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BEETHOVEN PORTRAIT, BY J. W. MAHLER.

(Original in possession of the Gesellschaft der Musikfreunde, Vienna.)

MAHLER'S PORTRAIT OF BEETHOVEN.

PICTURES of Beethoven have often been shown during his years of celebrity, but there is only one silhouette of him when young. Several small pictures were made of him soon after his first success as a pianist, including the miniature in 1802 by Hornemann. The first full length portrait of him in oil was painted about 1804 by J. W. Mahler. After this there appeared drawings and engravings, a bust and several portraits in oil, which are shown in a monograph treating of Beethoven's pictures and external appearance. Beethoven's wonderful rendering of "The Battle of Vittoria," at the musical convention, influenced the painting of several portraits, which followed each other in rapid succession, as the universal attention of the world was suddenly concentrated upon the now world-renowned master. Our picture is taken from the life-size portrait by J. W. Mahler, painted in 1814 or 1815, being the second one of Beethoven by this artist.

It belongs to the collection of pictures of musicians which has been for many years in the possession of a musical society in Vienna.

It has remained almost unknown and perhaps unappreciated, as it has been exhibited but once (in the year 1880), and has been hitherto unavailable for reproduction. Recently, through the efforts of the director of the conservatory, Joseph Hellmesberger, permission was obtained to copy this portrait.

The friends of Beethoven are familiar with a similar picture in possession of the Karajan family, a reproduction of which is owned by Baron Victor Gleichenstein at Freiburg.

The copy we present to our readers is taken from the portrait in the conservatory in Vienna, and, as already indicated, is the first copy that has been made public.—*Illustrirte Zeitung.*

POROUS EARTHENWARES.*

By CHARLES CARROLL GILMAN.

BY the courtesy of your secretary I am invited to talk to you to-day for a short time about "Terra Cotta Lumber and Its Future Uses" (which latter involve the probabilities of its future having something good in store for you)—a subject which I cannot treat comprehensively and to your satisfaction and my own, without to some extent embracing others bearing thereupon, which are quite as fruitful in suggestion; so if I confine myself to the necessarily short time allotted me, I can but touch lightly on any or all of them, even at the risk of not making myself well understood by all of you, for want of fuller elaboration, and that too, perhaps, in regard to the very points upon which you desire fuller information. As amends for such probable omission, I have to ask as a personal favor that you will make a mental memorandum, as such gaps occur, and interrogate me at the end of my discourse on matters not fully made plain, or perhaps wholly unnoted, but having connection with the topic, and I will do my best to explain them.

For the orderly handling of the subject, I shall treat it under five heads, to wit: "Fire-Proofing;" "Combustible and Incombustible Architecture;" "Porous Earthenwares — Their Invention and Manufacture;" "Protection Afforded by Patents;" "Clay Workers vs. Lumbermen."

FIRE-PROOFING

is an English-coined word of comparatively recent origin, and first used, so far as my investigation goes, in the description of an invention of James Conner, of New York City, in the year 1839, "For lining an iron box with a fire-resisting medium"—an original idea or discovery, so improved and developed in the nearly sixty years since expiring as to enable the production of the magnificent fire and burglar proof safe devices of to-day.

Soon after, in 1835, British patents were granted to one Obadiah Wyld, of England, for "so preparing paper, linen, canvas and such like substances, that they will neither flame nor retain fire, by dipping the fabrics into hot solutions of alum, borax, vitriol or copperas," and this process is cited in modern encyclopedias as "a case of fire-proofing." But these references do not touch the art we have in hand, to wit, that of

ARCHITECTURAL FIRE PROOFING,

which is beyond cavil of American invention, both in respect to materials and methods of construction (for without the first the latter could not be secured), unless, peradventure, the two-storied structures of iron, brick and glass, of fifty years ago or more—isolated efforts at best—may be properly classified as examples coming under this head, which will scarcely be maintained.

Real fire-proofing first began when bricks, for horizontal and vertical partition walls, were abandoned for less heavy incombustible materials, and iron was recognized as unsafe against heat, unless shielded by protective coverings. Beginning, say, with the building of the New York City Custom House, which was commenced in 1873 or 1874, incombustible substances, for interior house construction, made their appearance in rapid succession, as all improvements on really valuable inventions do, and in the following order, viz.: Grouting, tubular concrete, hollow blocks of Teil lime, ditto of plaster of Paris compositions, hollow pottery, or "hardware," as it is now termed in the West, and finally in the year 1881, terra cotta lumber, the first of porous earthenware compositions, from which (except to improvements on itself by the same inventor) there has been no appeal by the public for a better or cheaper substitute.

It is an ancient adage that "necessity is the mother of invention," but in the case of modern fire-proofing the invention seems to have had a dual parentage; for the necessity has been felt for many long, weary years for a more adequate protection than that afforded by fire-extinguishing appliances and fire insurance corporations against the red fire fiend whose ravages, in spite of such joint defense, require in the United States of America alone, in this day and generation, ten million dollars, monthly tribute, to repair. At any rate the invention sought was not made manifest until the vertical elevator or "lift," as it is termed by our British cousins, made its appearance, and its use was popularized in office and other public buildings for the accommodation of passengers. Not that the revolution in house construction directly originated in the elevator, but rather through "induction," to adopt the terminology of electricians, or because of its agency. I will explain.

Before the employment of elevators the popular way of reaching upper stories was by climbing stairs, and because of the labor and effort thus involved, apartments located higher than the third story above the street usually found none but unprofitable tenants. In metropolitan cities (and this is particularly true of favorite business locations therein) the lot on which an office building stood would in many instances bring in more money in the form of annual ground rent, if offered for long lease, than even the building itself; but with the introduction of the elevator it was quickly discovered by the sky-high lessee that he could more easily and quickly reach the fourth story than his neighbor of the ground floor, paying fifty times as much rent, could enter his domicile from the street. Fourth floors suddenly came into favor, the possible difficulty of exit in case of fire alone militating against an equal popularity with those nearer the ground.

It was at that particular time that "induction" began to get in its work, and the problem which puzzled active brains, "Why not twelve stories instead of four, and why not three times greater tenant capacity and consequent rentals, without additional land purchase, for lots in the air cost nothing beyond the expense of walling them in?" was solved; for somebody thought and said, loud enough to be heard: "It can be done if you fire-proof upward, as you go!" And then was the American art of fire-proofing born.

And now, strange as it may appear, we see displayed in this new architecture every sort of safeguard for the protection of life and property, possible for money to buy or the wit of man to devise, and that too at the expense of the same landlord who of old would not, unless forced by law, provide even a fifty-cent rope fire-escape for a timid tenant; and why? Because of "change of heart"? Oh, no! He has found out that a thoroughly fire-proofed building of twelve stories proves a more profitable investment than its predecessor, the four-storied tinder box construction, plastered over with underwriters' guarantees, which was torn down to make way for the experiment which has *paid*. When a revolution pays, it has come to stay. The adage "An ounce of prevention is worth a pound of cure," he has become convinced, is a solid chunk of wisdom where fire is concerned.

A few words descriptive of the art displayed in this modern fire-proof construction, and we will then drop the subject to take up another closely related and more interesting, because newer.

To you of an age rising fifty years, who as boys were reared in a timbered country, the recollection of an old-fashioned house or barn raising must still occupy a warm place in your hearts, and its mention recalls the thrilling scene when what seemed to youthful eyes to be a monster aggregation of pine sticks, of every form devisable, from the massive sill and stubbed post to the airy rafter, at a given signal from the master mind, rose all together, seemingly as though imbued with mute intelligence, each timber taking its respective place in the skeleton structure looming in perfect symmetry against the sky, transformed from ungainly lumber piles quicker than I have recited it, as if by fairy hands.

In this "old-time" substantial manner is the huge frame of twelve and fifteen stories of the present day erected, but the timbers come from an iron mine instead of a pine forest, and weld, key and rivet as fastenings, take the place of tenon, mortise and wooden pin. Here, then, of itself, is undoubtedly a fire-proof structure, but sheathe this iron skeleton with pine plank, boards and shingles, as the country barn or house referred to is finished, and in this combustible clothing kindle a flame and the stubborn iron columns and girders soon glow ruddily, then bend, and long before a frame of wood under like provocation would succumb, the iron frame, under the load of its own weight even, without other added burden, pitches headlong into the cellar.

But instead of wooden coverings, use those of a material which has once passed through fire in their making; wedge between the floor beams and rafters hollow blocks of porous earthenwares, and instead of hollow walls lathed and plastered, erect partitions and furrings of blocks of the same material laid in mortar, and to make assurance doubly sure, sheathe likewise the supporting girders and posts or columns, and a fire may be kindled on the floor of every room, in every story, and the structure will not burn.

This, as the word goes, is the "fire-proof construction" of the present day—an art, as a whole, known and practiced for scarcely more than a decade past.

The qualifications demanded of first-class fire-proofing fillings are:

First—That they shall have passed through quite as great a heat in their manufacture as will likely be encountered in their use.

Second—That they should be non-conductive of heat; otherwise, their unfitness as coverings for iron is manifest.

Third—That they should be water-proof as well as fire-proof; otherwise, upon turning against them a powerful stream from a hose, the wall would wash down, as is the case with plaster blocks; or becoming red hot, would, under like treatment, shiver and go to pieces, as does hollow pottery.

Fourth—That they should be light of weight, which should not be more than, say, about one-third that of building brick, so that too heavy a load may not be imposed upon the iron frames which carry them.

Fifth—That they should be of such a quality that mortars will adhere, and be held retentively under all conditions.

Sixth—That they should be sound-proof, so that division walls built of them may admit of no communication of sound whatever between contiguous apartments.

Seventh—That they should be penetrable to nails and sharp instruments, and susceptible to tooling, so that they may be nailed where the use of cement bonds is inadmissible, or that auger holes may be bored through floors for the introduction of gas or heating pipes, electric wires, etc., or that apertures in walls may be sawed, after they are built, as for doors and other desired alterations.

Eighth—Cheapness. Fire-proofing should not be an added expense to the ordinary cost of construction, but should be made to take the place of other materials—more than this, the cheapest of other materials.

COMBUSTIBLE AND INCOMBUSTIBLE ARCHITECTURE.

Under this head I shall seek to treat of humbler construction than that heretofore described, and with which you are all familiar—the simple architecture of village and country, built by the local boss carpenter, "out of his head" (the details of plans and drawings usually relied upon by the neophyte from past and long experience, all finding lodgment there), including dwellings, stores, warehouses, barns, etc. I refer more particularly to the style known as "balloon frames," the characteristic house construction of the Western States; and the fact that these frames are often surrounded by brick or stone walls, in place of wooden, will by no means exempt them from my criticism.

Are you aware that should a committee be selected from your members, composed of half a dozen men of the most ingenious constructive minds, possessed of long experience in kiln burning, and of special skill in supplying openings, draughts, and exits, so that heat and flame may be properly distributed at will in any and every direction, they could not possibly devise and submit any plan of house construction which would more perfectly invite accidental ignition, and conceal and protect its encroachments until, when bursting forth to view, entire demolition and disappearance in smoke and flame is but the work of minutes, than that of the house in which you live? Believe it or not, it is true, beyond the possibility of successful contradiction.

Every wall in your house is hollow, from cellar to roof-tree, vertical, horizontal, and inclining, outer division walls, floors and partitions, and even roof—all constructed of open frames of pine studding, interlaced with pine lath at distances of half an inch apart, and sheathed from observation by a coat of plastering on the outside, thus constituting a series of open flues connecting with each other from side to side, and from top to bottom, artistically filled with wood kindling, made as susceptible by age as punk to the touch of the insidious spark which, somehow, has the faculty of "getting there" in the most incomprehensible manner, and by all sorts of conveyances, dropping out of a stove-pipe joint, protruding through floor or wall, or arising from spontaneous combustion of greasy rags, stowed away in rats' nests, or coming from any other of a dozen accidental sources which might be mentioned.

How long such a fire may burn before discovery it is hard indeed to tell. It is never extinguished; for, plunge the ax into the wall of any room in the house you will, after the little column of blue smoke is seen ascending from the shingled roof, and you will find it there; an alarm—a rush—and all goes up in smoke, and not even the household gods are spared. You will all recognize this picture; its name is

COMBUSTIBLE ARCHITECTURE.

Now, again, allow me to draw another picture and a more pleasing one. Instead of covering the studded walls and floors of pine joists with wooden sheathings, and with lath and plaster, apply thin sheets of porous earthenwares, an inch to an inch and a half in thickness, twelve inches wide, and of a length to strike centers (usually twelve to sixteen inches), and nail firmly to place. The cost will be no greater than that of lumber and lath, where the former ranges at from $16 to $18 per thousand in price, and a "handy man" can do the work, no skilled labor being required to put them on. Then plaster floors and wearing surfaces with hydraulic cement, and walls and ceilings with lime mortar (one coat in either case is enough), and the expense of the new finish will be found to be no greater than of the old.

Or, if the building be of a more pretentious sort, and the outside or weather walls be of brick or stone, make the partitions and furrings of hollow porous earthenware blocks, laid in mortar and treated with plastering as before described.

Now, if this house gets on fire, the blaze will not be concealed for weeks and months, perhaps, nor will the embers lie smouldering in hollow combustible walls, until vent and air be given them, that they may eat through to the outside, but, on the contrary, will originate from visible causes—the explosion of a lamp, the overturning of a stove, or the incendiary firing of merchandise, for example.

Remedy: Shut the doors and confine the flames to the room in which they originated, for they cannot burn through to another, either down or up, or on either side. Then blow the horn for the man of the house, alarm the neighbors, or call the fire department (either will, for the time being, serve the purpose), then a judicious application of water, and that's the end of the fire. Such is

INCOMBUSTIBLE ARCHITECTURE.

"Porous earthenwares" is the generic name given to Gilman's several inventions of fire-proofing compositions, five in number, all of which are mixtures of earthy and vegetable matters, manufactured under a general formula, and alike yielding under fire treatment a cellular, bricken material, though each is distinguished by patentable characteristics, either of process or product, or both.

As progressive practitioners in brick making—a branch of clay working closely allied to architecture—and for this reason necessarily obliged to keep abreast of the times, in order to insure success, it is fair to presume that you are in a measure familiar with the art I am about to describe to an extent, at least, which will render an elaborate exposition of manufacturing and other details unnecessary, except so far as to identify and point out for your information the differences existing between these several products and their respective adaptability to various uses, thus likely suggesting new ideas to those of you who have never seen these wares employed otherwise than in works of masonry.

"TERRA COTTA LUMBER"

is the trade mark by usage and commercial name given to Gilman's first invention of 1881, which is a composition of kaolinic clays and sawdust, in such proportions that, when the latter is burned out in the firing process, the brick residue is sufficiently porous or cellular to be profitably worked with carpenters' tools, cor-

* An address, delivered by Charles Carroll Gilman, before the Illinois Brick and Tile Association, at its annual convention, held in Springfield, Ill., Jan. 13 and 14, 1891.

stituting, in fact, a lumber indestructible by fire or age, and suitable to be used wherever pieces of not greater length than two or three feet, or less thickness than one inch, can be employed.

Inasmuch as fire-proofing as an art is yet in a crude, undeveloped stage, restricted in its application, for the most part, to the building of walls of hollow blocks laid in mortar, the superiority of these wares over other fire-proofing is yet to be demonstrated, but in time is sure to be recognized, for the architecture of the present age is progressive, and it will be found that fire-proofing applications will be needed in construction which can be held together by other means than merely a mortar bond.

Where the conditions are most favorable for the manufacture of this ware, $5 per ton of 2,000 pounds will pay the bare cost of output, a ton in weight, when made under the established formula, equaling (board measure) three hundred square feet of sheets (solid), and four hundred of hollow blocks.

Its resistance, in fire tests, is greater than that exhibited by wares of common clay, but it is held by architects that this extra superiority has no value in house building, as inside walls are required to stand no greater heat than the outside, which are built of brick made of common clay. The disadvantages involved in its manufacture, as compared with that of surface clay mixtures, are several, the most prominent of which is the cost of the clay, by reason of its scarcity (except in favored localities), also its refractoriness to treatment, requiring heavy and costly machinery for grinding, and twice as great a heat for burning, involving the use of additional fuel, outside of the sawdust contained in the mixtures, to an amount equal in cost to at least one dollar per ton of product.

BRICK-WOOD.

This fire-proofing invention is of later date than terra cotta lumber, as an improvement on which it was patented in 1886, and is substantially the material made by Owen, at Hobart, Indiana, and the Illinois Terra Cotta Lumber Co., at Pullman, Ill., and the licensees in general of the International Terra Cotta Lumber Co. The "improvement" consists in the employment, in the place of fictile clays, of *long*, brick clays of alluvial origin, the deposits of which are common everywhere, so to speak, and for this reason have substantially no commercial value greater than that involved in the cost of digging and hauling.

The formula of manufacture differs little from that of the former named product, though the machinery required may, in a majority of instances, be of a simpler and cheaper kind, and will consequently need less power to drive it. A marked difference exists, however, in the manner and cost of firing the unburnt wares. The simple up-draught kiln of the brick maker has been found best suited in the place of the costly down-draught kilns required in the other instance, and a cherry-red heat, say 800 deg. F. (less than required for burning brick), is sufficient to bring the wares to the edge of vitrifaction—a heat that is quite fully supplied by the sawdust contained in the mixtures serving as fuel.

When sawdust can be obtained handily, and other conditions are fair, brickwood will pay a manufacturer's profit of 20 per cent. at the price $3.50 per ton, delivered at the factory door, a ton in weight being equal in measurement to four hundred feet, board measure, of sheet stuff (solid), and five hundred of hollow blocks. This is a noticeable difference in yield, as against terra cotta lumber, and in favor of brick clay compositions, and is occasioned by the purity of fictile clays, and their consequent and greater weight per given measure.

CELLULAR POTTERY.

As a composition, this ware differs only from brickwood in the substitution of cut straw or like vegetable matters, for sawdust, in the mixtures. This change, however, slight as it may seem at first glance, occasions a great difference in the burned product, and in its firing, because of the refusal of the plastic clay to mix as intimately with fibrous as with granular vegetable material. Besides, the straw has not the fueling properties of sawdust, and wood or coal fuel is required in addition, to co-act with it in firing.

This material is especially intended for cheap construction—for the building of workingmen's houses, a story and a story and a half in height, the wares being nailed, as sheathing on wooden frames, or of ranch buildings in dry and semi-tropical countries, where the adobe is now the principal building material, and where sawdust is difficult to obtain. In fact, this product is little more than *burnt adobe*, but its qualities, owing to its porosity, are infinitely superior to those of the adobe, being similar to those of the preceding wares named, because of the confined air in the cellular spaces contained, which renders it a practical nonconductor of both heat and cold, as well as of sound and electricity, and impervious to moisture, when erected on a proper, waterproof foundation, as water will not stay in a wall constructed of it, but rises rapidly to the top, through the influence of capillary attraction, and disappears by means of evaporation.

This ware is not readily penetrable to nails, but may be applied to wooden frames, by fastening at the corners of sheets, by means of a nail driven into the wood, a washer, the size of a dollar, each washer thus effectually holding the meeting corners of four sheets. Mortars anchor in it well, allowing of stucco covering on the weather side of the wall, and plastering without lath, on the inside. Conditions being equal, the cost of manufacture does not vary materially from that of brickwood.

A somewhat interesting phenomenon is observable in the pressing of this ware, as well also of all wares the composition of which embraces fibrous matters, for these, retarded in their progress through the press, assume a lengthwise position, parallel with the line of motion of the plastic mass, and after issuing from the die, if the column be broken and examined, it will seem to be full of strings, not unlike hair in mortar, but more orderly in their distribution, and apparently laid end to end as if so arranged by hand.

Pure clays, as in the manufacture of sewer pipe and drain tile, and such wares as pass through a "press of expression," unmistakably show a *grain* the "long way," and because of this, a greater strength lengthwise than transversely; but in the instance referred to, we have *fiber* as well as *grain*, analogous to that of wood, and conferring a special tensile strength. A section of given length of a green column, if taken by the hands at one end and twisted awry, will split cleanly in two, the entire distance. On the other hand, if the strain be applied at right angles with the length, and the section be bent backward and forth over the knee, the resistance is that of a withe of green wood, and only by repeated efforts can it be broken clear apart.

The fibrous strength is still better exemplified in drying. For example, if a column of green ware, four inches by eight, be cut off in twelve foot lengths, and carried to the drying room on a board of equal length or more, the latter, because of the load imposed, will bend or bow down in the center, to an extent which, to the bystander, would seem to make it certain that the column is fractured; yet when turned off upon a flat surface, it will immediately straighten of its own weight, showing no fracture then, nor after drying or burning.

This mixture shrinks in drying and burning a little less than one per cent., that is to say, an inch to the foot. A twelve foot column would therefore shrink one foot, and in the operation it does not shrink apart, but, because tied as it were longitudinally by the fibers, it literally shrinks into itself. Here lies the idea held by the inventor as to its value for building purposes in the shape of scantling, posts and joists, when strengthened by a metal core. The suggestion may be worth something to you, particularly when coupled with another, viz.: That such construction before or after erection can, in the hands of a skillful plaster worker, be made to counterfeit perfectly marbles and many varieties of stone. Pieces of any length, which can be safely handled in a green state, can be manufactured. Mr. Owen, of Hobart, Ind., has made joists fourteen feet long—pretty big specimens of brick!

HOLSTEIN, OR WOOD-STONE,

is the fourth composition, in the order of invention, for fire-proof building purposes, and is really a combination of the previous inventions described, inasmuch as it blends with the clay, vegetable matters, both granular and fibrous, and of course accomplishes the results in process and product, represented in each, enabling the making of hollow blocks of a size equal to that of building stone, as usually employed in outside walls—say twelve inches square, by twenty-four to thirty-six inches in length—which will dry and burn safely, and when dried and burned, afford a substance practically imperishable, that will receive and hold nails, allow treatment by edged tools, be susceptible to great ornamentation by the plasterer, and cheaper than any other known building material.

These hollow blocks weigh, when burned, from thirty-eight to forty-two pounds per cubic foot, which equals, of course, twelve feet, board measure, to wit: twelve feet long, by one foot wide, and one inch in thickness, a ton of 2,000 pounds at this rate equaling say 500 square feet, one inch in thickness. If sold at $8 per ton, it would be equivalent to lumber at $16 per thousand, or 1,340 common building bricks at $6 per thousand, which would amount to $8.04.

FIBROUS BRICK

is Gilman's fifth patented composition, and is substantially what its name indicates; not fibrous in the same manner as No. 3, or cellular pottery, in its green state, when it contains a fiber which fulfills its purpose in holding the wares together while drying, and is eliminated in firing, leaving the product porous or cellular, but a burnt brick product, strengthened by a fiber as indestructible as the brick itself, which is mixed with it when plastic, and burned with it. This result is accomplished by sparsely mixing with any of the previous compositions described, except No. 3, asbestos wool, such as is commonly used for covering steam pipe and boilers, and which must not be confounded with mineral wool, though both are of clay origin—the first found native, in rock seams of peculiar formation; the other, manufactured from the impurities, or slag, which float on melted iron, and which, although resembling sheep's wool at sight, crumbles into powder with so slight a compression as can be given by the closed hand.

The asbestos fiber is sprinkled into the plastic composition and, in passing through the press and dies, exhibits the same peculiarity in straightening out and running lengthwise through the die, as already noted in the case of fibrous vegetable matters.

To be sure, fibrous brick, although it may be treated with edged tools like wood, and possesses a fiber in many respects similar to that of wood, is not wood by any means, either in strength or elasticity; still it will stand a tensile strain greater than brick, and is elastic enough, when slit by a saw into half inch strips, to spring without fracture, to an extent that renders it useful for paneling, veneering, and similar uses, where a thin covering must be used, fastened either with glue or by fine nailing. Indeed, it may be fairly considered a material for joiners' and cabinet makers' use. Its weight does not materially differ from that of No. 4, but it is necessarily more expensive, owing to the cost of asbestos, and because of the delicate, finished forms in which the wares would be demanded by the trade, though this finishing need not necessarily be performed by the clay worker, who would doubtless prefer to furnish artisans the composition in the rough.

RECAPITULATION.

Mud and vegetable refuse, machine mixed and ground plastic with water into a homogeneous compound which in turn is, by steam or hydraulic power, forced through "presses of expression" into compact forms demanded for building, and subsequently dried artificially and burned, much as charcoal is made, by the ignition and combustion of its own gases, in which process the vegetable matters are expelled, leaving spaces of their own form, and the whole a bricken residuum, so honey-combed and porous as to be wrought, as wood is wrought, might perhaps be considered a fair syllabus of the lengthy descriptions I have given you of the various fire-proofing compositions set forth. Behind all this is an art of manipulation—an art gained only by experience and which cannot be intelligibly described on paper, but must be imparted by personal instruction and oversight—an art akin to the art of brickmaking, yet widely different in first principles; more complex, yet simpler—a paradox explainable only by the clay worker who has acquired them both.

THE PROTECTION AFFORDED BY LETTERS PATENT.

Some thirty or more, individual, United States patents, and twice that number issued by foreign countries, have been granted on the various inventions of porous earthenwares and their applications; yet the promoters of the industry founded upon these inventions are shy about boasting of such protection, because it smacks unsavorily of monopoly; yet this fact exists and should not be counted prejudicial to the business so long as all are invited to join in the exploitation of the art, a tax of a small royalty fee only being imposed for the privilege.

If infringers may be believed (and ours, like all other valuable inventions in their early stages, is not exempt from the blood-letting of this pestiferous tribe), the mixing of earthy and vegetable matters, for brick-making or brick-burning, is an ancient art. Not impossible, but yet to be proved! So too, very likely, and yet more ancient, was that of mixing flour and water for food making; but what a difference between *hoe cake* and *sponge cake;* and the composition of the latter—a triumph of culinary art which is the Ultima Thule in cookery of every good housewife's aspirations—was not dreamed of, fifty years ago.

Our peculiar wares, which even to this day cannot be made, successfully at least, without an acquired knowledge of our formulas of manufacture, and generally needing, besides, the personal tutelage of an expert in the art, for the education of practitioners, were never made, until the invention of the "press of expression" was perfected; for without that they cannot be made sufficiently strong, yet light of weight, and in the hollow forms demanded of modern fire-proofing. The precise date of the appearance of this auxiliary invention has escaped my mind for the time being, but within your recollection and mine, all drain tile presses paid tribute to the "Tiffany," the "Original Jacobs" in the line of such machinery. And I can further say with equal confidence, that no use or demand for such compositions existed prior to the discovery of the art of fire-proofing, the origin of which I have already recited to you, and that as soon as the invention of a new fire-proofing composition was announced through the press, *i. e.*, terra cotta lumber, a demand for it instantly sprang up, sporadically, from every quarter of this country, and even from England and Continental Europe, where clay working was an art before the discovery of America. The question of validity of patents and priority of invention is now before the courts, but the introduction of the "new industry" must not be delayed for their decision. I say it for your information, however, that licensees cannot be legally forced to pay royalties on invalid patents, should they by such decision prove so.

CLAY WORKERS VS. LUMBERMEN.

And now after all this preamble—a talk of an hour's duration—I come to what is to you the real pith of the whole subject, viz.:

What is there in this new industry for the profitable occupation of brick and drain tile makers?

Allow me to tell you *what;* and after reflection, as thinking men, you will of yourselves see even more.

It has been the pine forests of Michigan, Wisconsin, and Minnesota that yielded housing to the settlers of our Western country, particularly to those of the treeless prairie States to which lumber is conveyed by water and rail transportation, vast distances from its place of origin. These immense pine forests have nearly disappeared, the best authorities on the subject limiting their future supply, at the average cut of the last decade, to twelve years longer, at the outside. What then is to become of the lumbermen; of the vast hordes of hard-fisted ax swingers, mill sawyers and raftsmen who will then be left without another world to conquer? Will you wait for them to become workers of mud, or will you, seeing danger in this prospective influx to the ranks of your craft, prepare your shoulders to receive their mantle; for the day is near at hand, when by State enactment, all buildings for the protection of man, beast, and merchandise must be built of incombustible materials—buildings of metal ribs and bricken walls—and those of your generation and mine will live to see these house frames shipped, ready for erection, from Pittsburg, Birmingham, and Duluth factories, to all parts of this country, even to the far West, and some of you of this very audience will in this very town assist in clothing such frames with porous bricken material made out of the cellars of such houses, as it were. Hold me to this prediction, and write me at the end of five years, if it has not come true.

Mr. Abbott, chairman of Carnegie, Phipps & Co., the largest firm of architectural iron workers (rolled girders, beams, etc.) in the State of Pennsylvania, lately assured me with his own lips that, after the practical experiments made by him, or of his own personal knowledge, during the past year, with porous earthenwares for house construction, he did not hesitate to offer it as his opinion, as a practical iron worker and business man, that when mills were prepared to roll light work, business houses and dwellings could, as a rule, be erected as cheaply of terra cotta lumber with steel frames, as of brick and wood.

The synopsis of a report, now in the publisher's hands, appeared in Boston papers, the last week of December just past, from which I will quote for your further information. A committee, consisting of William Minot, Jr., J. G. Stearns, and W. H. Sayward, assisted by J. E. Cheney, consulting engineer, and E. T. Cabot, counsel, all first-class citizens of Boston, and competent to the work assigned them, was appointed by the mayor of that city, a year ago, to examine into the causes of, and report with recommendations upon, the great conflagration of the preceding Thanksgiving Day, occurring in the busiest business portion of the city.

From this report—a very exhaustive document—I cut the following:

"The loss by fire in the city of Boston has been, during the last thirty years, in round numbers one hundred million of dollars. With interest added upon the sums of money lost from the date of loss, the sum total more than equals the present valuation of all the taxable buildings in the city of Boston, which is two hundred and forty-four millions of dollars (1889). If the amounts paid for insurance and for the maintenance of the fire department during the same period were added, with interest, the total amount would very

far exceed the *value of all the buildings in Boston today, public or private.* If the money, which has been lost by fire, and expended in insurance premiums and in the maintenance of the fire department, should be paid into the city treasury to-day, with interest, there would be *more than enough to duplicate every building in Boston and pay the city debt.* There would probably be enough to build anew every building in Boston, making them all as nearly fire-proof as the wit of man and money can make a building."

Are not the citations thus given strong enough in character and language to arrest your attention long enough to start you thinking?

Boston declares in so many words that practically that city is rebuilt every thirty years, that is to say, that the money which that city cost is substantially re-expended every thirty years, in insuring against and repairing the damages from fire.

Boston boasts of a solid building construction, and if the statements given be true of Boston, conservative, granite-walled Boston, why not as well of every American city, and if true of cities, why not of country, where fire departments and fire extinguishing appliances do not abound, where a fire is a "touch and go" affair, that is, the fire *touches* the inmate before he can *go* out of the house?

If this deduction be logical, then we Americans, every thirty years, pay in insurance and repairs necessitated by fire, an amount equaling the first cost of all improvements upon the land which, after all, is only a fire insurance of 2½ per cent. for thirty years, at compound interest. It is high time to call a halt, and the Pittsburg iron-master has sounded the key note of a revolution in our every-day architecture in which you clay workers, as active participants, will cut no mean figure in carrying it to a triumphant conclusion—a revolution which will convert our houses of kindling wood into homes that can be bequeathed as such to our children after us from generation to generation, because guaranteed from destruction by fire, or absorption of value in premiums paid on fire risks.

Once convinced of this being a fact, it belongs to clay workers as well as iron workers, as evangelists, to propagate the new gospel, preach the glad tidings, and to vie with each other in the primary stage of the art, in erecting such experimental work as individuals, as will suggest still other and better, until as a whole, results be obtained that will warrant the architect and builder in indorsing the new departure, from their own knowledge gained by personal observation of the same.

Leaving to philanthropists and economists the sentimental side of the question, having reference particularly to the comfort and saving involved, and looking at the subject strictly from a business standpoint, it seems as though the tile maker, whose plant requires little change to fit it for the new manufacture, were warranted in beginning in his own practical way, to see what he can accomplish in this direction; what success he as an individual will be able to report at your next annual meeting, as having been made in venturing upon this new ground. The conversion of a tile mill into a lumber mill requires little time or money, and if this architectual departure prove all it now promises, proselytes to the new faith will not be lacking in such numbers as will make the change profitable from a financial point of view.

To any and all, wishing to venture into this new field, I shall be glad, if desired, to impart any expert knowledge I may possess, that may be needed, free of expense, if confined to correspondence.

It is not necessary to wait for steel beams. Let them follow. Make a plan of a small office building, or even smoke house, and buy pine or hardwood joists for floor and rafters, then under the directions I may send you, inclose them with porous wares, cementing the faces of the latter, and you will find you have a house construction in which you may burn a kiln of tiles without danger of destruction.

KAOLIN.

By GRAHAM SPENCER.

FOR the last fifty years the manufacture of china in this country has been steadily growing, and is now an important industry, and one that is increasing in the quantity as well as quality of its goods yearly. The first pottery in America was established in Philadelphia about half a century ago, by a man named Tucker, who carried on the business for some time, making very excellent semi-porcelain ware. Since then, Trenton, New Jersey, is the great point of manufacture east of, and East Liverpool, Ohio, west of the Alleghanies. Besides these, Baltimore, Wheeling, Steubenville, Beaver Falls and Cincinnati, and a number of other places have one or more potteries located in them.

The great bulk of kaolin, or china clay, used in the potteries of the United States is mined in this section. The amount of prepared clay shipped last year was nearly twenty thousand tons.

Kaolin results from the decomposition of a rock composed of feldspar and quartz; and is found in pockets or beds, in low and very often swampy ground (I speak of kaolin found in this vicinity), the clay underlying the surface soil holding the water. The amount of covering varies; in some cases being less than eight feet from the surface, and in others as much as forty. The pockets are of an oblong shape, the general direction being northeast and southwest. The kaolin is found bedded against veins of talc, which determine the width of the pocket. The talc is very irregular in its pitch, but eventually cuts the clay out. The talc is in turn bedded against partly decomposed mica schist, and very often against a vein of iron or manganese.

There are no surface indications of kaolin, and it is generally proved by boring or sinking small shafts. After having determined the position of the deposit, the dirt is stripped off and the clay uncovered, and taken out by means of carts, cars or derricks, as the case may be. From the situation of the pit, which is generally in the lowest ground, there is no opportunity for drainage after you are down any depth, and constant pumping becomes necessary, not only of surface water, but of large springs, which burst out from the sides of the pit and through the banks.

The clay is taken from the pit to the washing machine, which is a three or four inch shaft, according to the power you have, placed horizontally, with knives at right angles, about four inches apart, made of three-inch by inch iron, twelve inches long. The whole is inclosed in a stout framework, with a pulley at one end of a shaft connected by belt with main shaft, and an opening made at the other end of the machine for the escape of the clay and sand. The shaft is set in motion, a stream of water turned on, and the clay thrown in the top as fast as a man can shovel it. The sand or quartz coming out with clay and water settles in a box, where it is continually being shoveled out.

The clay, combining with water, and of the thickness of cream, is allowed to run slowly off into a number of troughs for a time, until all the impurities have had a chance to settle. It is then turned into large vats, where it remains until quite thick. It is then pumped into presses, which are a number of wooden panels held together by iron rods—each panel containing a canvas bag. The water escapes through the pores of the canvas, and leaves the clay in such a condition that it can be handled and placed on shelves in the open air to dry, after which it is ready for shipment.

Kaolin, both in a crude state and washed, is much improved by exposure. If placed in piles, and allowed to freeze and thaw during the winter, it will be found much tougher in the spring. A strong, tough clay is of much more value to the potters, as it enables them to make thinner ware. It is said that in the manufacture of the finest ware, in China, one generation mines the clay for the next to use.

The average yield of washed kaolin from a ton of crude clay is from thirty to fifty per cent. I have never seen crude clay in any quantity which would yield above that.

The quartz, washed from the crude clay, is of the purest nature; and when pulverized is worth about $12.00 per ton, and is sold to the potters—they using it in the body of their ware, and also with feldspar as a glaze.

The mica or talc which is washed from the clay, and settles in the troughs, makes a good fire brick.

In conclusion, to give a general idea of the size of the deposits of kaolin in this section, I would say that in the pit I am now working, the clay had been proved at a depth of ten to sixteen feet from the surface, for over 300 feet in length and 80 to 100 feet in breadth; and in depth 50 feet, and still clay. The greatest depth I have ever been down, in any of my pits, is ninety feet, the strata of clay continuing, but which had to be abandoned on account of the expense of keeping the dirt from caving in.

The color of kaolin varies from a pure white to a yellow (as shown in the specimens), the white being more valuable. The yellow and the white clay are often found banked against each other, and running vertically downward, side by side. The clay is hard to excavate, and requires the strongest steel pointed shovel for work, being dug in sods.—*Proc. Eng. Club.*

HARNESS BLACKINGS, POLISHES, AND WATERPROOF COMPOSITIONS.

PROPERTIES of a good blacking are: That it makes the leather both soft and flexible and that it shines or polishes with slight friction. It is not manufactured as the ordinary boot and shoe blackings are, but where animal charcoal is used this substance is very often best prepared before use so that the phosphate of lime may be removed, which otherwise would give an inferior blacking, and present a grayish tinge instead of a black one.

It is therefore advisable to treat the bone black; 20 parts of it may be taken and treated with six parts of pure hydrochloric acid, it is then allowed to stand for 24 hours, and 100 parts of boiling water added and allowed to settle. Draw off the liquid and then treat the sediment with five parts of pure concentrated sulphuric acid, again stand by for 24 hours, add another 100 parts of boiling water, and draw off. When the sediment is deposited this residue is then nearly pure and free from acid, and is capable of producing a good blacking of a deep color. Other blacks that are frequently used are Frankfort black and lamp black, which do not require the above treatment; Berlin blue which has been freshly precipitated also gives a most beautiful color of a metallic luster, but is more expensive.

Every blacking must also contain a substance which will cause it to adhere to the leather, so that the color may become fixed. This is attained by the addition of a mixture of 2 parts of molasses and 1 of glycerine; where glycerine is not used other substances take its place, to render the leather soft. This is accomplished by using one of the following oils, which are of a non-drying character, olive, sesame, lard, fish, seal, sperm, but good cod liver oil of the curriers answers better than all; white of egg, isinglass, and flour are injurious, as they grow mouldy and will not keep, as well as producing cracking. Resin oil should also be avoided as unfit for blacking. The following are some receipts for the preparation of various blackings, etc.

Harness polish is made by breaking 4 oz. of glue in pieces and pouring over it 1 pint of vinegar. This is allowed to remain until perfectly soft, then make another solution of 2 oz. of gum arabic and half a pint of black ink, to mix add another half pint of vinegar to the glue solution over a moderate fire, but do not let it boil. When it is dissolved add the gum solution, keep at a temperature of 180° F., and further add 2 drachms of isinglass in a little water, then remove from the fire and draw off for use. It is to be applied by a sponge, and a very thin coat given, allowing to dry quick, which gives a better polish.

Harness blacking is made by melting 2 oz. of mutton suet and 6 oz. of beeswax together, then add 6 oz. of sugar candy, 2 oz. soft soap, 2½ oz. of lampblack, ½ oz. of powdered indigo, and when thoroughly mixed add ¼ pint oil of turpentine.

Another is prepared by taking 1 lb. of beeswax, 4 oz. of animal charcoal, 1 oz. of Prussian blue, ground in 2 oz. of linseed oil, 3 oz. of oil of turpentine, 1 oz. of copal varnish. These are to be well mixed and formed into cakes while warm. Another blacking may be formed by adding to this last one while warm, 4 oz. of soft soap and 6 oz. of oil of turpentine.

Waterproof harness paste is made by putting into a glazed vessel 2 oz. of black resin, which is melted over a fire. When dissolved add 3 oz. of beeswax, and when this is melted remove from the fire, then add ½ oz. of fine lampblack, ½ a drachm of Prussian blue in powder. These are stirred well together, and enough turpentine is added to form into a thin paste. Allow to cool, apply with a sponge, and finally polish with a soft brush.

Harness grease. Take ammonia soap 4 parts, palm oil 1 part, ordinary hard soap 3 parts, solution of tannin (9 to 16 of tannin in 4 of water) 1¾ parts, melt the oil and soap together, then add the ammonia soap and the tannin solution, and thoroughly mix. No more of this grease is to be used than the leather will absorb, and it should be kept in a stone bottle well corked. The ammonia soap is previously made by heating olive oil to boiling point, and adding sesqui-carbonate of ammonium until the odor of the ammonia no longer disappears.

Another blacking is made by taking ¼ oz. of isinglass, ¼ oz. of fine powdered indigo, 4 oz. of soft soap, 5 oz. of glue, 4 oz. of logwood, 2 pints of vinegar, ½ oz. of ground animal charcoal, and 1 oz. of beeswax. The color of the logwood is to be extracted by putting it into the vinegar and applying a gentle heat, then strain it and add the other ingredients, boil till perfect solution takes place, and store up in glass or stone ware jars. This is very useful for army harness.

A good blacking for a working harness, which is to be applied with a sponge and polished with a brush, is prepared as follows, and should be applied at least once a week. Melt 4 oz. of mutton suet with 12 oz. of beeswax, then add 12 oz. of sugar candy, 4 oz. of soft soap dissolved in water, and 2 oz. of fine powdered indigo. This, when well mixed, is thinned out with half a pint of turpentine.

Blacking for harness. Treacle 8 oz., lamp black 1 oz., one teasponful of yeast, sugar candy 1 oz., olive oil 1 oz., gum tragacanth 1 oz., and 1 oz. of isinglass. To this is added a cow's gall, then mix with 2 pints of stale beer, and stand by the fire for one hour.

Another polish for carriage harness, which must not be applied too frequently, as it is liable to crack the leather, is made from 3 sticks of black sealing wax, dissolved in half a pint of alcohol, and applied with a sponge, or a similar one may be made by dissolving lac in alcohol, and coloring black with lamp black.

Harness that has become soiled can be restored by the use of the following French blacking: 4½ lb. of stearine, 6¾ lb. of turpentine, 3 oz. of animal charcoal. It is prepared by beating the stearine into thin sheets, then mixing with the turpentine, and heating in a water bath during continual stirring, then the charcoal is added and the whole placed in another vessel and stirred so as to prevent it crystallizing. It must be warmed when using and rubbed on with a cloth as quickly as possible, giving it a very thin coat, and when nearly dry polish with a silk cloth.

Another blacking: Treacle 8 parts, lamp black 1 part, sweet oil 1, gum arabic 1, isinglass 1, water 32. Melt all together, and when cold add 1 oz. of spirits of wine, apply with a sponge, and if required, warm it before use by placing in hot water.

To preserve harness and leather exposed to the action of ammonia given off in stables and which causes it to rot, although it may be protected by grease, is to add to the oil or fat that is employed a small quantity of glycerine, which is said to keep the leather always soft and pliable.

Black harness lacquer. Dissolve 40 parts of best shellac, 10 parts of sandarac, and 5 of mastic in 500 parts of spirits of wine. To prevent it from becoming brittle, add to the solution 20 to 30 parts of Venetian turpentine, and finally sufficient aniline black (nigrosine) dissolved in water or spirits of wine to color.

A waterproof liquid is made from India rubber in chips 1 oz., and boiled oil one pint, dissolving by the aid of heat, then finally stir in another pint of hot boiled oil. Another waterproof composition is boiled oil 1 pint, 2 oz. of beeswax, 2 oz. of yellow resin, and melt all together. Or, take 1 pint of salad oil, 4 oz. of mutton suet, 1 oz. of spermaceti, 1 oz. of white wax, and melt together. Another is prepared from 2 oz. of bisulphide of carbon, ½ oz. of gutta percha, 2 oz. of asphaltum, ½ oz. of brown amber, 1 oz. of linseed oil. First dissolve the gutta percha in bisulphide of carbon, and the asphaltum and amber in the oil, and thoroughly mix together.

A lacquer for harness makers is prepared from the following: 5 parts of colophony, lampblack 1 part, mastic 2 parts, sandarac 5 parts, shellac 20 parts, Venetian turpentine 5 parts, spirits of wine 100 parts.

Composition by Farnham of glycerine and other resinous substances used for forming a base for a high polish, rendering it impervious to water and preserving the flexibility of the leather; resinous substances by themselves are objectionable, because in becoming dry they crack and cause the leather to break, but by mixture with glycerine the composition formed excludes the water and preserves the softness. It is made as follows: 1 gallon of 94 per cent. alcohol, 1 lb. of Venice terebinthina, 1 lb. of gum shellac, 1 lb. of glycerine, 4 oz. of myrtle wax, and fine lamp or ivory black to give color and consisteney. It is prepared by digesting the gum in the alcohol till dissolved, a portion of the glycerine is used in grinding the myrtle wax, and a portion in grinding the blacking so as to render it soluble in alcohol. Mix all thoroughly and apply with a sponge or brush; castor oil may be used with the glycerine resin for carriage tops and other work where a brilliant polish is not required.

A good oil for farm and team harness is made by melting 3 lb. of beef tallow, but do not let it boil, then pour in gradually 1 lb. of neatsfoot oil, and stir till cold. If properly prepared the grease will be perfectly smooth and soft, if not it will be more or less granulated. A little lamp black may be used to color.

English ball blacking for harness is made from 1 oz. of lard, 1 oz. of beeswax, 8 oz. of ivory black, 8 oz. of sugar, 4 oz. of linseed oil, and 2 or 3 oz. of water; or it may be composed of 8 oz. of beeswax, 4 oz. of ivory black, 2 oz. of Prussian blue, 2 oz. of spirts of turpentine, and 1 oz. of copal varnish. Melt the wax and stir in the other ingredients, and when cold roll into balls and use as required.—*Harness.*

DATA of the trials of three large steamers, showing the comparative merits of large and small screws, show that propellers of small diameter have in each case proved the more economical and effective, both increasing the speed and decreasing the coal consumption.

BOILER DEPOSITS.*

By Professor VIVIAN B. LEWES, F.C.S., F.I.C., Associate.

TWO years ago I had the honor of reading a paper before this Society on "Boiler Incrustations," in which I traced the formation of the scale, and the causes which led to the precipitation and hardening of the calcic sulphate, calcic carbonate, magnesic hydrate and other compounds which are usually found to be present, and I pointed out that the scales formed by various kinds of water were so characteristic that one could speak with certainty as to the kind of water from which the incrustation had been formed by an analysis of the scale itself. The analyses given below may be looked upon as typical of the incrustations formed by fresh water, brackish water, and sea water respectively:

Constituents.	River.	Brackish.	Sea.
Calcic carbonate	75·85	43·65	0·97
Calcic sulphate	3·68	34·78	85·53
Magnesic hydrate	2·56	4·34	3·39
Sodic chloride	0·45	0·56	2·79
Silica	7·66	7·52	1·10
Oxides of iron and alumina	2·96	3·44	0·32
Organic matter	3·64	1·55	trace
Moisture	3·20	4·16	5·90
	100·00	100·00	100·00

From this it is evident we may look upon the incrustation from fresh water as consisting of impure calcic carbonate, while that from sea water is impure calcic sulphate, the brackish water from the mouths of rivers yielding, as might be expected, an incrustation in which both these compounds are present in nearly equal quantities. The importance of these differences in the deposit formed is very great, as it enables the shipowner to arrive at a conclusion as to the treatment that the boilers have received during the voyage, by examination and analysis of the scale which those boilers contained. Taking, for instance, the case of a ship which uses fresh water both for filling and make-up, it is manifest that on her return to port the scale should be very slight, and should consist mainly of calcic carbonate, while, if the scale exceeds $\frac{1}{16}$ in., and shows a preponderance of calcic sulphate, it is manifest that such scale could only have been formed by sea water, either leaking in from faulty condensers or being deliberately fed into the boilers. The reception you were kind enough to give that paper, and the frequency with which it has been quoted since, lead me to hope that, in continuing and completing the subject, I shall be performing a not unwelcome task.

So far the deposits taken into consideration have been those formed from the impurities natural to the water itself; but with the introduction of high pressure steam a new and highly dangerous form of deposit has added to the trouble of the marine engineer. As early as 1878 the collapse of the furnaces of the boilers of the s.s. Ban Righ, and a similar misadventure in the screw tug Ich Dien, with no apparent cause to bring about the damage, caused some attention to be paid in marine circles to the action which had taken place, and the only clew to be found was that a certain amount of oily deposit had formed on the tops of the furnaces; and experiments made by Mr. Dunlop, of Port Glasgow, led to the conclusion that this oil, which had distilled into the boiler from the lubricants used in the cylinder, was so bad a conductor of heat that its formation on the plates allowed them to get superheated, with the result that they were unable to withstand the pressure of steam existing in the boiler, and in this way brought about the collapse. Similar cases of collapse became frequent after that date, no less than thirty vessels being disabled from this cause during the last few years. The first case which came under my notice, in which damage to boilers had arisen from this cause, was the case of a large ocean steamer, and through the kindness of Mr. Milton, chief superintendent engineer of Lloyd's, I was able to obtain samples of deposit from all parts of the boilers, and full particulars of the case. The steamer was a large one trading between Liverpool and Boston, averaged twelve days on the voyage, and was fitted with ordinary compound engines. She had three double-ended boilers, with three plain furnaces at each end, and three combustion chambers in each boiler. The furnaces were plain, in one length, and connected at the back end to the tube plates, being flanged up inside the chamber, while the front end plate was flanged inward on to the furnace crowns. The furnace crown was $\frac{1}{2}$ in. plate, and the front bottom plate $\frac{11}{16}$ in., the working pressure being 80 pounds. The boilers were about five and a half years old, and had always been refilled with fresh water at the end of each run, both at Boston and Liverpool; while, as a rule, the waste on the voyage was made up by the use of about 70 tons of fresh water, but during the last voyage sea water was used for this purpose. Every four hours while under steam 4 pounds of soda crystals were put in the hot well, making about 2 cwt. during the run, the total capacity of the boilers being about 31 tons. For lubricating purposes about seven pints per day of valvoline were used in the cylinders. When in port the boilers were allowed to cool down, and the water was run off, and they were swept down with stiff brushes, and were afterward sluiced out with a hose shortly before being refilled with fresh water. No trouble occurred with the boilers until five voyages before the final collapse, when some of the furnaces began to creep in; they were stiffened with rings and stays, and on the succeeding voyages the whole of the furnaces got out of shape, one after another. Examination of these boilers clearly showed that they had never been very heavily scaled, as in parts of the boiler where it would have been impossible to get at them to clear them out, no signs of heavy incrustation were to be found, and the absence of marks of scaling tools also showed that they had never been allowed to get very dirty. On the furnace crowns, where they had collapsed, there was only a slight white scale, not more than $\frac{1}{64}$ in. in thickness, while on the bottom of the furnaces there was a brown oily deposit $\frac{1}{16}$ in. in thickness, which in other parts of the boilers increased to between $\frac{1}{8}$ in. and $\frac{5}{16}$ in. I obtained from Mr. Milton samples of the thin scale from the top furnaces, and of the deposit from various parts of the boiler, and also specimens of cut-out portions of the boiler plates, Liverpool water, valvoline, and soda crystals put into feed water, and of all these analyses were made. The boiler plates were as good as the day they were put in, and showed no structural signs of having undergone any change, while the analyses of the Liverpool water and the soda crystals used showed that they could have taken no part in the action which had led to collapse.

The valvoline on analysis gave:

I.—*Valvoline.*

Vegetable and animal oil	nil
Mineral oil	100 per cent.
Acids (free)	nil
Boiling point	371 deg. C.
Specific gravity	0·889

II.—*Scale from Furnace.*

	From top.	From below.
Calcic sulphate	84·87	59·11
Calcic carbonate	5·90	6·07
Magnesic hydrate	2·83	11·29
Iron, alumina and silica	2·37	2·85
Organic matter and oil	3·23	19·54
Moisture	0·80	1·14
Alkalies	nil	nil
	100·00	100·00

III.—*Deposit from Tubes.*

	Scale on tubes.	Deposit above scale.
Scale sulphate	50·92	11·60
Calcic carbonate	4·18	0·83
Magnesic hydrate	14·12	22·21
Iron, alumina, silica, etc	7·47	9·14
Organic matter and oil	21·06	50·20
Moisture	1·17	4·23
Alkalies	1·08	1·80
	100·00	100·00

IV.—*Deposit from Bottom of Boiler.*

Calcic sulphate	22·52
Calcic carbonate	nil
Magnesic hydrate	7·09
Silica, alumina, and iron	34·85
Organic matter and oil	27·95
Moisture	5·79
Alkalies	1·80
	100·00

On careful examination of the organic matter and oil present in these deposits, it was found that quite one-half of it was "valvoline," in an unchanged condition, which had collected round small particles of calcic sulphate. A consideration of these analyses, at first sight, yields no clew as to the cause of the collapse, the scale upon the furnace tops being not only free from oil, but perfectly harmless both in quantity and quality; but, on going more deeply into the question, it is evident that this scale cannot be in the condition in which it was originally formed, as the deposits from both top and bottom of tubes, from the bottom of the furnaces, and from the shell of the boiler are all rich in oily matter; and it is impossible that, during this deposition, the furnace tops could have escaped while all other parts of the boiler became coated with it. Experiments, however, reveal the actions which had been at work and led to the formation of the deposit, and its absence upon the injured portions of the plates. The pressure at which the boilers were worked was 80 lb., corresponding to a temperature of 155 deg. C. or 311 deg. Fah., which is so far below the boiling point of the valvoline that it was evident that it had not distilled over in the ordinary way, and experiments were made to see if it could be distilled in steam at a lower temperature. A retort containing valvoline was carefully heated over a sand bath, its temperature being ascertained by a thermometer, and steam was then blown through it, with the result that at 248 deg. Fah., or 120 deg. C., the steam became "greasy" and the oil commenced to pass over with it.

This experiment is, I think, important, as it shows that, in testing the capabilities of a lubricant, the fact that it has a boiling point well above the temperature of the steam is no guarantee that none of it will find its way into the boiler. Having thus entered the boiler, the minute globules of oil, if in great quantity, coalesce to form an oily scum on the surface of the water, or, if present in smaller quantities, remain as separate drops, but show no tendency to sink, as, their specific gravity being 0·889, they are lighter than the water, and the difference in gravity is probably even greater at the temperature existing in the boiler. Slowly, however, they come in contact with small particles of calcic sulphate and other solids separating from the water and sticking to them, they gradually coat the particles with a covering of oil, which in time enables the particles to cling together or to the surfaces with which they come in contact. These solid particles of calcic carbonate, calcic sulphate, etc., are heavier than the water, and, as the oil becomes more and more loaded with them, a point is reached at which they have the same specific gravity as the water, and then the particles rise and fall with the convection currents which are going on in the water, and stick to any surface with which they come in contact, in this way depositing themselves, not as in common boiler incrustations, where they are chiefly on the upper surfaces, but quite as much on the under sides of the tubes as on the top, their position being regulated by whether they come in contact with the surface while descending or ascending. The deposit so formed is a wonderful non-conductor of heat, and also from its oily surface tends to prevent intimate contact between itself and the water. On the crown of the furnaces this soon leads to overheating of the plates, and the deposit begins to decompose by the heat, the lower layer in contact with the hot plates giving off various gases which blow the greasy layer, ordinarily only $\frac{1}{64}$ in. in thickness, up to a spongy, leathery mass often $\frac{1}{8}$ in. thick, which, because of its porosity, is an even better non-conductor of heat than before, and the plate becomes heated to redness, and, being unable to withstand the pressure of steam, collapses. During the last stages of this overheating, however, the temperature has risen to such a point that the organic matter, oil, etc., present in the deposit burns away, or, more properly speaking, is distilled off, leaving behind, as an apparently harmless deposit, the solid particles round which it had originally formed. Such a deposit is much more likely to be produced with boilers containing fresh or distilled water, as the low density of the liquid enables the oily matter to settle more quickly, while with a strongly saline solution it is very doubtful if this sinking point would ever be reached; it is evident also that, when oil has found its way into the boiler and is causing a greasy scum on the surface, the most fatal thing that can be done is to blow off the boilers without first using the scum cocks, because as the water sinks so the scum clings to the tops of the furnaces and other surfaces with which it comes in contact, and, on again filling up with fresh water, it still remains there, causing rapid collapse. A very remarkable instance of this is to be found in the case of a large vessel in the Eastern trade, in the boilers of which an oil scum had formed. The ship having to stop some days at Gibraltar, the engineer took the opportunity of blowing out his boilers, and refilling with fresh water, with the result that, before he had been ten hours under steam the whole of the furnaces had come in. Under some conditions the oil-coated particles coalesce and form a sort of floating pancake, which, sinking, forms a patch on the crown of the furnaces at one particular spot, and under these conditions the general result is the formation of a "pocket."

A curious fact, which is worthy of attention, is that in most of these oily deposits copper is to be found in considerable quantity. In an analysis of a deposit from the furnace of a vessel in which a "pocket" had formed from the above-mentioned cause, the scale showed, as in the case already cited, no reasonable cause for the injury at the damaged part of the boiler, while the deposit from the under side of the furnace tubes showed clearly the presence of large quantities of oil matters, which were partly combined with copper:

Constituents.	Scale.	Deposit.
Calcic sulphate	90·354	1·02
Calcic carbonate	1·200	nil
Ferric oxide } Oxide of alumina }	3·200	56·90 / 2·30
Oxide of copper	nil	1·90
Magnesic hydrate	2·821	1·80
Organic matter } Oil }	1·600	10·46 / 17·84
Sand, etc.	0·825	7·78
	100·000	100·00

It is a fact that even mineral oils have a considerable solvent action upon copper and its alloys, and it is evident that the copper in the oily deposits had been obtained from the fittings of cylinder and condenser. Fortunately this copper is so well protected by oil that in most cases it is extremely unlikely to come in contact with, and deposit on, the metal of the boiler; but, if it did, very serious galvanic mischief would be the result.

The next point I attempted to determine was the effect which these oily deposits had in allowing excessive heating of the plates to take place, and retarding the heating of the water. A clean iron vessel was taken, and a known volume of water placed in it, and heated by a carefully regulated Bunsen flame, the water being raised to the boiling point in ten minutes; this experiment was repeated a second time with the same result, and the vessel was then lined with a coating of deposit found in the bottom of the boilers which had collapsed, and rendered binding by admixture with a small trace more valvoline. This coating was laid on $\frac{1}{16}$ in. in thickness, and the former experiment repeated, the same flame being used and the same volume of water taken, with the result that it took fifteen minutes before the boiling point was reached, showing that, even if no damage resulted to the plates from overheating, such a deposit would cause a large increase in the fuel used. In attempting to ascertain to what extent extra heating of the plate took place from this cause, I employed a series of substances of known igniting and melting point, raised the water in the various vessels to the boiling point, and then brought the clean bottom of the vessel in quick contact with the test substance, and took the results as indicating the temperature of the exterior of the plates:

Clean vessel	Sulphur did not melt	below 115 deg. C. = 239 deg. F.
Coated vessel	Sulphur melted, but did not inflame	above 115 deg. C. = 239 deg. F. below 250 deg. C. = 482 deg. F.
	Gun-cotton ignited	above 200 deg. C. = 392 deg. F.

So that the $\frac{1}{16}$ in. of deposit caused with a slow heat a rise in temperature of the plate from under 115 deg. C. or 239 deg. Fah. to over 200 deg. C. or 392 deg. Fah. It is manifest, however, that the fiercer the heat the more marked will this overheating become, and in the next series of experiments the Bunsen flame was replaced by an atmospheric blowpipe, and the temperature attained tested in the same way as before.

Clean vessel	Sulphur did not melt	below 115 deg. C. = 239 deg. F.
Coated vessel	Gun-cotton ignites	above 200 deg. C. = 392 deg. F.
	Tin melts	" 228 deg. C. = 444·4 deg. F.
	Sulphur ignites	" 250 deg. C. = 482 deg. F.
	Lead melts	" 334 deg. C. = 633 deg. F.
	Zinc melts (just)	" 423 deg. C. = 793·4 deg. F.

While, on replacing the atmospheric burner by an oxy-coal gas flame, I found no difficulty in fusing a hole in the bottom of the vessel, which was made of thin wrought iron plate, showing that a temperature of 1,500 deg. C., = 2,732 deg. Fah., had been attained, and it is therefore manifest that, with the fierce heat existing in the boiler furnaces, given an oily deposit only $\frac{1}{16}$ in. in thickness, the plates will readily be heated to a temperature at which they are totally unable to withstand a pressure of 80 lb. of steam, and collapse of the furnace crowns must follow.

The great points to be sought in a good lubricating oil are that it shall be a pure mineral oil, and that its boiling point shall be well above any temperature likely to be attained in the cylinder. Oils satisfying these requirements can readily be obtained, but users of lubricants must remember that, in order to obtain them free from any constituents of dangerously low

* A paper recently read before the Institution of Naval Architects, London.

boiling point, expensive processes have to be resorted to, which must of necessity increase the price of the oil, and that it is useless to expect to obtain a really good lubricant at a low figure.

The great advantage of a good mineral oil cannot be too strongly insisted on, and any lubricant containing animal or vegetable oils to give it body should be unhesitatingly discarded. The mineral oils are not fats, but hydrocarbons—compounds of carbon and hydrogen—and the portions used for lubricants are those left after the more volatile constituents have been distilled off, and they differ widely from animal and vegetable oils, which contain so-called fatty acids, which are liberated from them by the action of superheated steam, and these acids attack iron, copper, and copper alloys with the greatest readiness, forming metallic soaps, which are compounds of the fatty acids with the oxides of the metals, and so cause serious damage to both boilers and fittings. The animal and vegetable oils, in contact with air, especially when heated, take up oxygen, and become gummy and resinous, and gradually so stiff that frequent cleaning becomes necessary, a trouble entirely avoided with mineral oils.

In dealing with the prevention of such deposits, it seems to me that the most feasible plan is to pass the feed water through a long tube filled with clean coke in pieces the size of walnuts, which would act as a scrubber, and would free the greasy water from the traces of oil, and prevent their going forward to the boiler. I have already pointed out that the collapse of furnaces from the presence of oily deposits almost invariably takes place in boilers fed with fresh water; and that oil, when it goes into the boiler, floats because it is specifically lighter than water, until solid particles of calcium compounds coming in contact with it and embedding themselves in it so increase its weight that, reaching the same density as the water, it commences to circulate with the convection currents in the water, and is so drawn down and attaches itself to tubes and furnace crowns, causing eventually damage. In the case of a transatlantic liner using fresh water only, it takes at least four days' hard steaming to bring the density up to $\frac{1}{16}$; while if sea water had been used the density would have started at this and would never, after the first few days, have been much below $\frac{1}{32}$, and the oil would have remained as a scum and would never have reached the furnace crowns.

In my last paper on boiler incrustations I pointed out that it was quite possible to prepare sea water in such a way as to practically prevent any serious deposit forming from it, and the same process would prevent the trouble I have now been describing to you.

In the summer of last year Mr. Biles, who is always to the front when he thinks there is a chance of improving marine engineering, kindly gave me the opportunity of trying the effect of prepared sea water upon a crane boiler at the Naval Construction Works, at Southampton, and, after a few preliminary experiments to determine the best form in which to work the "precipitator," the boiler was worked continuously for a month with water drawn from the Itchen half an hour before high tide, at which period analysis showed that the water was to all intents and purposes sea water plus a fair amount of suspended mud. This, after preparation in the "precipitator," was fed into the boiler, and on opening it in the presence of Mr. Milton, Mr. W. H. Riley, R.N., Mr. Biles, Mr. Gearing, and Mr. Dusantoy, it was found perfectly clean, the surfaces looking as if they had been given the thinnest possible coat of whitewash. The process employed was to add to the sea water a known quantity of precipitator powder, consisting chiefly of soda ash, and having done this in a closed vessel, to heat the mixture by blowing into it waste steam, until a pressure of from 5 lb. to 10 lb. was created, and under these circumstances practically all the magnesium and calcium salts separate from the water and are easily got rid of by filtering it under pressure into the hot well. I had proposed in the first case to heat the liquid by blowing the steam through a coil in the precipitator, but practical experiments soon showed that the heating surface was not nearly enough, and so the waste steam was simply blown in, allowance being made in the precipitator for the water due to the condensation. I also found it aided the reaction to heat the water first just to boiling point before adding the precipitator powder, as under these circumstances the deposit settled more quickly and threw less strain upon the filters. The precipitator was 6 ft. 4 in. high and 3 ft. in diameter, and held a ton of water, and the time taken from the first running the sea water in to its delivery into the hot well was one hour fifteen minutes, so that in practice, giving plenty of time between the makes, it would be perfectly easy to prepare eight to twelve tons in the twenty-four hours with a small precipitator of the size used. The prepared water has a density of $\frac{1}{16}$, and may with safety be evaporated until its density is $\frac{1}{8}$, the salts present not crystallizing out until a density of from $\frac{1}{12}$ to $\frac{1}{10}$ is reached.

Professor Doremus, of the College of the City of New York, proposes to use sodic fluoride as a precipitant for the scale-forming constituents of sea water, as a smaller weight is required, and the action is more rapid and more perfect. The great objection has up to the present time been its cost, but I am informed that this has now been so far reduced as to bring it within the scope of extended commercial use; and, should it be used on a larger scale, the price could be readily brought much lower. Professor Doremus claims that the precipitation of the calcium and magnesium salts takes place with very great rapidity, that the sediment shows no tendency to cake or adhere to the sides of a hot vessel, and that it is less bulky than the precipitate formed by soda ash. In preparing sea water in the way I have proposed, every precaution must be taken to add slightly less of the precipitant than is necessary to entirely throw down the calcium and magnesium salts, as it is manifestly impossible in practice to guard against small quantities of sea water finding their way into the boiler, either from leaky condensers or else being fed in by the engineer during some emergency, and if under these conditions any excess of the precipitant were present in the boiler, a bulky precipitate would be thrown down and cause trouble, although it would not bind into a solid scale. There is no doubt that, if Prof. Doremus can so reduce the price of sodic fluoride as to enable it to be used for this purpose, it would be of great use, as the fluoride undoubtedly completes its action on the salts of magnesium and calcium more rapidly and thoroughly than the soda ash, and it would be easier, therefore, so to regulate the quantity added as to remove say five-sixths of the injurious constituents from the sea water without allowing any precipitant to enter the boiler.

I conclusion, I will briefly recapitulate the means which seem to me best adapted for preventing the formation of the dangerous organic and oily deposits I have considered in this paper, and these are: (1) Filtration of condenser water through a coke column; (2) free use of the scum cocks; (3) the use of water of considerable density rather than of fresh water; (4) the use of pure mineral oil lubricants in the smallest possible quantity.

HARBORS, NATURAL AND ARTIFICIAL.*

By F. H. CHEESEWRIGHT.

I KNOW of no more absorbing subject in the whole range of the science of engineering than that of the construction of harbors, rendered necessary where the coast line of a country does not afford, by inlets, shelter for its ships.

It is my intention, by means of this paper, to lay before you drawings and charts of some of the most notable of the natural harbors, as well as artificially made harbors, and give such explanations as I consider necessary for your information. There is a considerable amount of danger in dealing with the subject in the form of a short paper, inasmuch as it is one that could easily occupy a great deal more time than I intend to give to it here. I, therefore, have carefully made a selection of such artificial and natural harbors as would commend themselves, in several ways, to your notice, as being historical, and as showing, in some instances, the difficulties engineers have to overcome, and the way, and at what cost of time and money, this was accomplished. I intend commencing from the earliest date until the present time, and leave you to form your own deductions as to how far the science of harbor engineering has progressed.

The importance of the subject admits of no denial; and we find, from the earliest ages, that nations holding command of the sea were generally the most powerful and studied with the greatest care the art of preserving and improving their harbors, to protect the ships while at anchor.

As an early example, mention may be made of the Phenicians, who, from only possessing a narrow strip of barren land along the coast of Syria, became the most wealthy and greatest of nations, and were only subdued by Alexander, after a great struggle, and by the help of, it may be said, the whole world.

Again, the Greeks, by their command of the sea, maintained their independence with a mere handful of men against the millions of Xerxes.

The Carthaginians made head against and almost conquered the mighty Romans, who only recovered their ascendency and ultimately overwhelmed their formidable adversary by acquiring command of the ocean. And, although the Romans were naturally averse to the sea and the pursuits of commerce, yet feeling that the preservation of their empire depended on their maritime superiority, they devoted the greatest care and attention to the perfection of their fleets and harbors, as the magnificent remains in Italy, and other places I shall have occasion to mention, afford ample testimony. These works prove that the ancients had made considerable progress both in the theory and practice of marine architecture.

After the fall of the Roman empire, the whole civilized world became enveloped in darkness; and it was not until trade and commerce began to revive, and the ocean was again covered with numerous fleets, as well for war as for merchandise, that the necessity for providing for them against storms became apparent.

Then it was that the rival republics of Genoa and Venice perceived the necessity of improving their harbors, in order to protect and facilitate the commerce from which they derived their wealth, power, and greatness, as well as to enable them to extend their conquests.

Hence arose the magnificent moles of Genoa, and the still more extraordinary works of the port of Venice. France now began to devote her energies to the subject, and the entrances to the ports of Havre, Dieppe, Calais, Boulogne, and Dunkirk were improved, by adopting the system of confining the mouths of the streams which formed these harbors by jetties or groynes, and thus giving them a proper direction at their points of junction with the sea, by damming up their water and discharging them through sluices at low water, so that the increased velocity and force of the current or scour thus created might remove any accumulation of sand or shingle to which the harbors on the north of France are subject.

Sir John Rennie, in the preface to his "Theory, Practice, and Construction of British and Foreign Harbors," 1854, says:

"The great extent of commerce in every part of the world, the countless fleets of shipping, which constantly traverse the ocean in all directions, the immense number of valuable lives and vast amount of property involved, render it imperatively necessary upon all maritime nations to provide safe and convenient harbors."

I propose to deal first with natural harbors.

Some parts of the British coasts, as well as the coasts of other countries, are amply provided with natural bays or creeks, while Ireland and the west coast of Scotland are also plentifully supplied with excellent deep water bays and anchorages, but on the east and southwest shores of Britain there are but few natural harbors.

A natural harbor may be defined as a bay, recess or inlet of the sea, or the mouth of a river which affords good anchorage and a safe station for ships. The great requisites (adequate depth both of entrance and interior area being assumed) are shelter from wave violence, good holding for anchors, and accessibility at all times. More than one entrance, with different exposures to the wind, is desirable, but seldom attained, even in purely artificial harbors. To insure shelter, it is necessary that the communications with the ocean should be as nearly as possible reduced to a channel of entrance of adequate width, *i. e.*, that the waters of the harbor be, in expressive nautical phrase, "landlocked," and that the entrance be sufficiently wide and the water deep enough to allow vessels of any tonnage to enter at any state of the tide—a desideratum rarely met with.

The first natural harbor I shall direct your attention to is that of Rio de Janeiro, or January River, as having the most beautiful scenery, and being perfectly safe as an anchorage.

RIO DE JANEIRO.

This harbor has been pictured and praised ever since it was discovered, and will be while ships and commerce last. Its acknowledged rivals, San Francisco and Constantinople, can never boast of greater natural advantages than these; a clear approach, an unobstructed entrance, wide enough but not too wide, with fifty square miles of anchorage ground within, and more for light draught vessels. Not a tenth part of the space is used now, and ships have room enough and to spare.

I have been with matter-of-fact and phlegmatic men who grew enthusiastic when they passed the sentinel sugar loaf rock, and saw this splendid bay for the first time.

It is not alone the mountains (those are strange and grand rather than beautiful), but the rocky points, the picturesque side bays, the green hills and islands, the by-places and glens. Away beyond the city the blue water stretches almost to the Organ Mountains, land of purple romance, where the jagged rocks are all mellowed and dissolved in the soft haze, and you see nothing but outline, with the finger-like Dedo de Deos at one end of the range. Some of these peaks are 6,000 feet high.

Rocks, by no means insignificant, are on either side. There is the conical sugar loaf at the entrance of the bay, a mass of 1,200 feet high. Beyond the city is a huge cluster, with the Corcovado and Syrica rising above it, further back the Gavea and Tres Irmaos; across the bay other clusters not so high, but everywhere with abrupt hills and precipices of the purple-brown gneiss. Even the water is not free from these peaks; there are rocky islands here and there, and

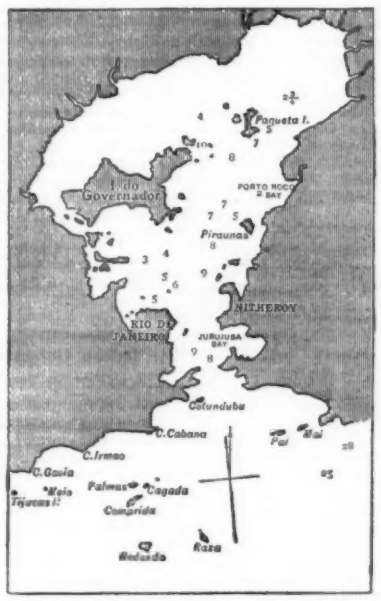


FIG. 1.—HARBOR AT RIO DE JANEIRO.

some of them are crowned with buildings, forts, naval store houses, and convents. The old monks must have chosen these sites for picturesque effect.

There is no limit to the beauties of this bay. You go sailing along the shores, and every headland and nook is a delight, with nodding and flowering shrubs. Then there is the shipping, which an artist like Turner would have delighted in.

Ships are picturesque everywhere, but in Rio Harbor they are supremely so. I know not if it be the limpid water, or the background of hazy mountains, or an indescribable something in the air, but there are no other ships like these, not even on the Hudson, where the sloops and schooners are all enchanted. There are monitors, expensive toys of the Brazilian government, which does not need them all, and gun boats and war steamers, English ships, French, Portuguese, German; rarely one that carries the American flag, though many belong to American merchants, and are commanded by American masters.

KING GEORGE'S SOUND AND PRINCESS ROYAL HARBOR.

These form the most southwest portion of Western Australia.

The entrance to King George's Sound lies between Bald Head and Herald Point, at 5 miles north by east from it; and it is divided into three channels by Breaksea and Michaelmas Islands. The sound is about 5 miles wide, north and south, and 5 miles deep, with average depths of 10 to 5 fathoms sand. On the south side of the sound there is a deep 2 miles long, north and south, and 1 mile broad, having 11 to 20 fathoms, with 7 to 10 fathoms close around.

Princess Royal Harbor is the most convenient of the inner ports of King George's Sound. The entrance, which is about a quarter of a mile wide, lies between Possession and King Points. Its depth in the Fairway Channel is about 25 feet at low water spring tides. The harbor is 4½ miles long, northwest and southeast, and about 2 miles wide; is very shoaly at its west and southern sides, the available portion, for vessels drawing more than 3 or 9 feet, being about 2 miles square.

The harbor here is considered by all authorities al-

* A paper recently read before the Society of Arts, London.

most perfect, and it will not be very long before it is thoroughly fortified, and turned into a great port for war vessels.

It was first used by whalers in the earliest days of the colony; traces of their residence here can be seen

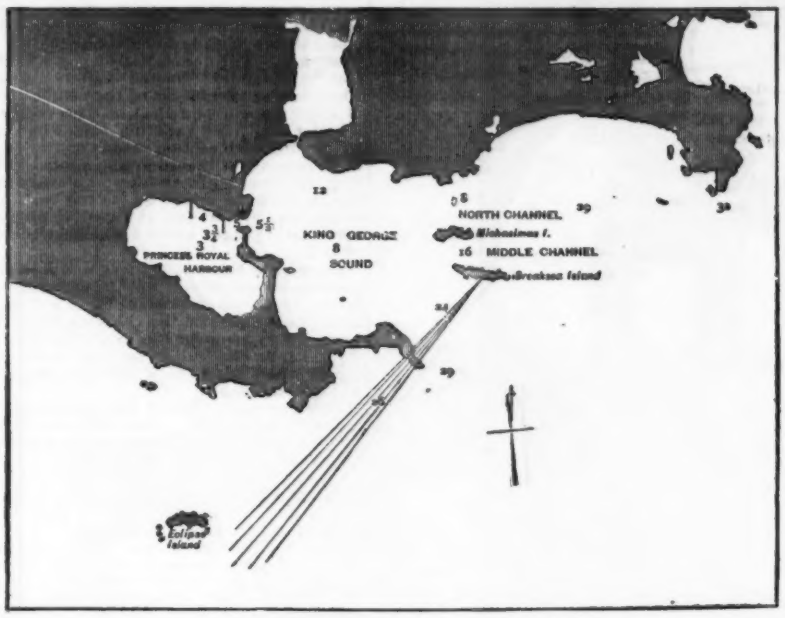


FIG. 2.—PRINCESS ROYAL HARBOR.

now, some of the pathways being made of whales' bones.

PORT JACKSON.

It seems strange that Port Jackson was not visited or explored by Captain Cook. It was seen only at the distance of between two or three miles from the coast. Had any good fortune conducted him into the harbor, he would have found it much more worthy of his attention, as a seaman, than Botany Bay, in which he passed a week. Governor Philip, the first governor who landed at Port Jackson with the earliest settlers (convicts), pronounced it to be a harbor in extent and security superior to any he had ever seen, and the most experienced navigators who were with him fully concurred in that opinion. From an entrance not two miles across, Port Jackson gradually extends into a noble and capacious basin, having water sufficient for the largest vessels afloat, and space to accommodate with perfect security any number that could be assembled. It runs in a westerly direction about thirteen miles into the land, and contains not less than 100 small coves or inlets, formed by narrow necks of land, whose projections afford admirable shelter from all winds.

Sydney Cove lies on the south side of the harbor between five and six miles from the entrance. The necks of land that form the coves are mostly covered with timber, yet so rocky that it is not easy to comprehend how the trees find nourishment. But the soil between the rocks is very good, and into those places the principal roots have found their way. Sydney, the capital of New South Wales, is built on the side of one of its bays. Its streets are narrow and tortuous.

Port Jackson, independently of being the port of the metropolis of New South Wales, is justly extolled as the most commodious and secure harbor on the east coast of Australia, and perhaps the finest in the world, and although vessels have sometimes been wrecked in attempting to enter, these disasters, in most cases, may be attributed rather to want of judgment and common prudence than to any real difficulty in making or entering the port. The characteristic features of the coast to the northward and southward of Port Jackson assume different aspects; for although North Head with its immediate vicinity presents a high, table-topped, precipitous appearance, yet the high, undulating hills, thickly covered with trees, which rise from the coast farther to the northward, are strikingly in contrast with the sterile, table-topped cliffs that extend to the southward of the port; and would, even if the lighthouse did not figure conspicuously, point out whether the land seen is to the northward or southward of the entrance of Port Jackson.

Port Jackson is 1¾ miles wide between Outer North and South Heads, but the narrowest part, or what may be considered the actual entrance, lies between Inner North and South Heads, where it is little more than three-quarters of a mile across from cliff to cliff, but this breadth is reduced by a rocky spit on each side to barely three-quarters of a mile. The entrance is clear of dangers, and the soundings are regular, the depth in mid-channel being 17 fathoms

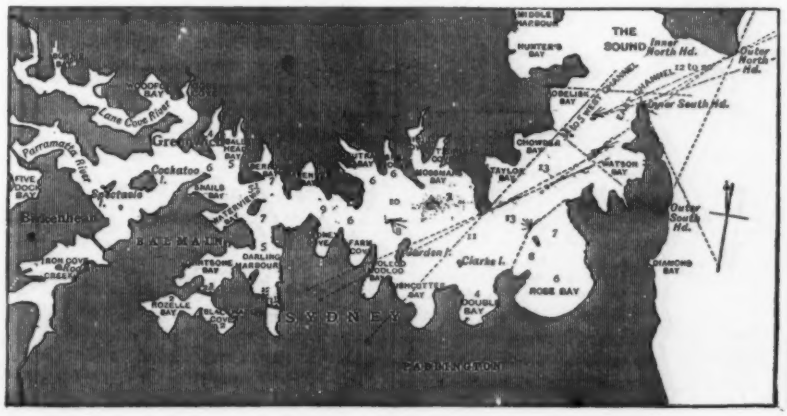


FIG. 3.—PORT JACKSON.

sand. Although there is a depth of 9 to 13 fathoms within a cable of the northern shore, the sea generally rolls in and breaks heavily upon the cliff. The Sound is that part of Port Jackson immediately within the entrance which branches off into Spring Cove and north and middle harbor. Although the Sound occupies an area of 1¼ square miles, with regular soundings in 8 and 9 fathoms, it is too exposed to the ocean swell to afford safe anchorage except with offshore winds.

NELSON, NEW ZEALAND.

The harbor of Nelson is safe, but small, and difficult of access to large sailing vessels. It owes its foundation to a most singular "bowlder bank," which extends

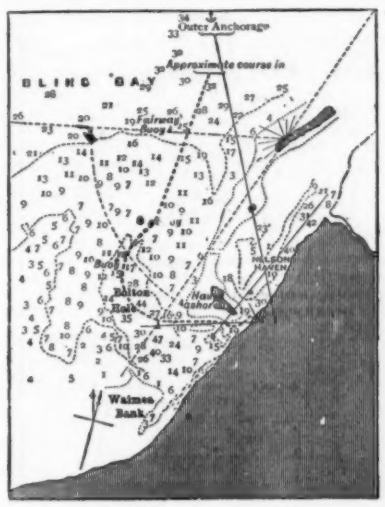


FIG. 4.—HARBOR AT NELSON, NEW ZEALAND.

eight miles along the coast, forming a natural dam, behind which there is a narrow and shallow arm of the sea, which grows deeper at its southern extremity, where it communicates with Blind Bay, and here forms the harbor. The entrance to the harbor is between the southern extremity of the "bowlder bank" and the mainland, but is narrowed so much by the Arrow Rock (a rock rising in the middle of it) that the navigable channel is only fifty yards wide. Owing to the extremely swift current of the tide in this narrow channel, and its shallowness, larger vessels can pass in and out only at high water, and are, moreover, obliged to watch the tide in coming and going. These unfavorable circumstances would greatly hinder navigation but for the excellent anchoring places outside the harbor, which, by the sheltered situation of Blind Bay, are safe in almost any kind of weather. During northwesterly gales, the neighboring Croixelles harbor offers a perfectly safe place of refuge. The "bowlder bank" is one of the natural curiosities of New Zealand. It consists of rounded pebbles or bowlders. In time of high water, a large portion of it is under water; at low water it is dry throughout its whole length.

The largest and heaviest bowlders are toward the seaside, on the harbor side the bowlders grow smaller; and at a point close by the entrance to the harbor they are so small that vessels there can drive on to the strand without any damage, thus using the place as a natural dry dock, in consequence of the great difference of the water level, between ebb and flow (spring tides rise fourteen feet). The bowlders consist of all one and the same kind of syenite, containing blackish green hornblendes, flesh colored feldspar, and a small quantity of iron pyrites. On following the narrow bank from north to south, it is easily observed that the bowlders toward the north grow larger and more angular, and originate from a precipitous bluff of syenite, called "Mackay's Knob," which abuts upon the sea a little beyond Drumduam, the residence of Mr. Mackay. The fragments constantly falling from the cliffs are gradually rolled toward the south by the heavy northerly swell, combined with a strong current of the sea, passing, in time of spring tide, with considerable velocity along the coast. The reason of their being deposited on the existing line seems to be that a submarine reef probably underlies them, of which the Arrow Rock, in the entrance of the harbor, may be regarded as the southern termination. The "bowlder bank" in front of Nelson is a fine study for the geologist.

PORT PHILIP.

Port Philip is another very extensive natural harbor, being 30 miles from east to west, and about 32 miles north to south. The entrance is very shoaly and difficult to navigate in certain winds. Melbourne is situated on its north shore and Geelong on the west.

There are other natural harbors existing in New Zealand; for instance, those of Auckland, Wellington, and Massacre Bay, or Golden Bay, as it is now called; all of which may take rank with the finest to be found in any part of the world, whether in regard to their accessibility, extent of shelter, or quality of anchorage. But I think I have given sufficient information for the purposes of this paper. I could have included Constantinople and San Francisco as worthy of mention, also Cork and other places.

It will be seen, from the examples of natural harbors I have shown, how few countries possess them; and where shipping is the principal support of a nation's greatness, the necessity must occur of constructing harbors or artificial places of refuge. The subject is one of the greatest importance to us, as well as to other countries. Every winter's list of shipwrecks and loss of life reminds us how much nature has left for skill and science to accomplish.

I now proceed to the consideration of artificial harbors.

For the most complete body of evidence regarding the ports of Great Britain, I cannot do better than refer you to the volumes of reports by the tidal commission, for the completion of which the world is indebted to Captain Washington, the present hydrographer to the Admiralty.

In the formation of a harbor, the first thing to be done is to erect a breakwater, or, in other words, to construct an artificial barrier destined to break the force of the waves.

And here let me call attention to the fact that there is absolutely no advance upon the method adopted by the ancients; for it was easy to imagine the man of those early days throwing stones into the water to create a barrier, so that his dugout might ride in safety. Throwing stones is the system of the present day; no alteration, no improvement or advance in any way, if we except the use of Portland cement. This material has certainly assisted the engineers of our time in raising high monuments of their skill, which might have otherwise been impossible. But the majority of these costly structures are built on a tumble stone foundation, as at first used by the ignorant man of ages ago.

Among primitive works, the piers of the ancient Piræus and of Rhodes may be denominated breakwaters; as also similar modern structures, projected from the shore, and called piers or moles. But the term breakwater has of late been considered as more peculiarly appropriate to large insulated aggregations of stone, whether of regular masonry or sunk promiscuously in rough masses, so placed as to form an artificial promontory or island across the mouth of an open roadsted. This, by obstructing and breaking the waves of the sea, converts a dangerous anchorage into a safe and commodious harbor for the reception of ships of war and merchandise.

In this sense of the term, the breakwater at Cherbourg was the first work entitled to the name, and it remains still the greatest.

FAMAGOUSTA.

This ancient mole is formed of rubble stone thrown into the sea, each stone weighing between two and three

FIG. 6.—FAMAGOUSTA—SECTION OF ANCIENT MOLE.

hundredweight. That portion of it which rises above the water is topped with a layer of square hewn stones, bedded and jointed in mortar. These covering stones are about three feet long and eighteen inches wide. The capping is almost completely destroyed, having been gradually swept away, in the course of long years, through the continual action of the waves. Much of

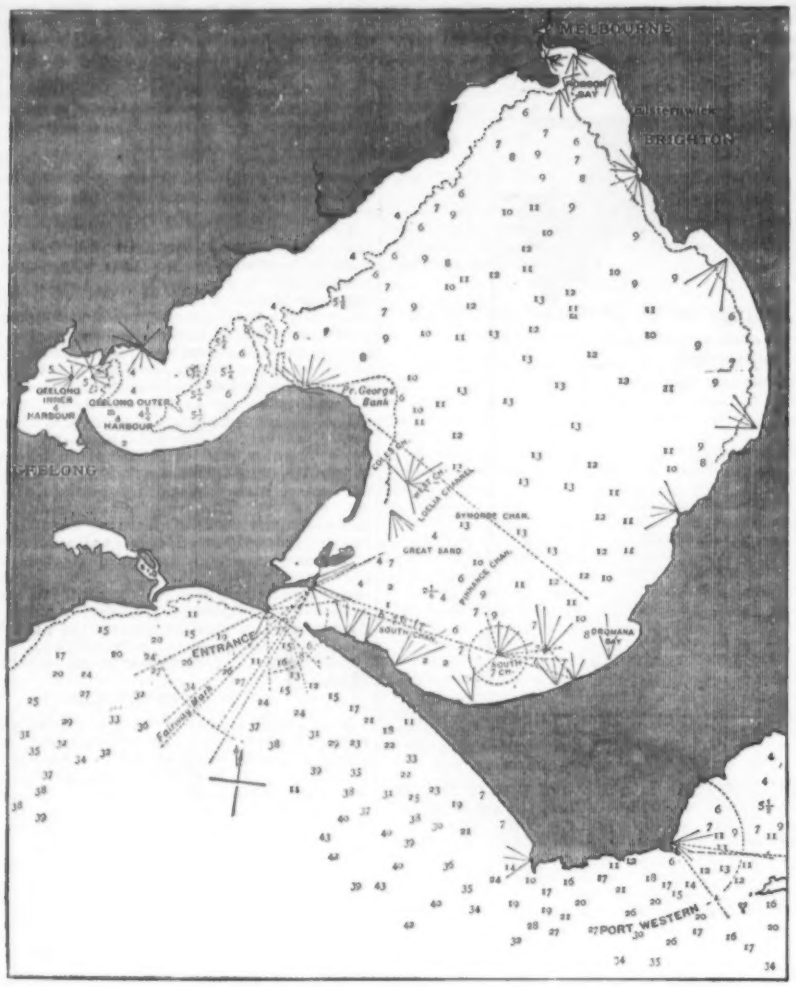


FIG. 5.—HARBOR AT PORT PHILIP.

the *débris* has been swept toward the entrance of the harbor, which it has, consequently, narrowed.

ALEXANDRIA.

The ancient mole of Alexandria has been utilized as the basis of the modern breakwater. The modern breakwater was begun in 1870, and finished in two

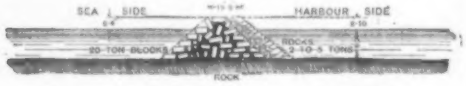


FIG. 7.—ALEXANDRIA—SECTION OF BREAKWATER.

years. In addition to the fact that the groundwork of it had already been laid, this rapidity of construction was largely due to forced labor employed upon it, and there being no tide to contend against.

MARSEILLES.

The Marseilles breakwater (begun in 1845 and finished in 1881) consists also of a *pierre perdu* foundation, which is faced seaward with blocks of concrete averaging a greater weight than those at Alexandria; the foundation supporting a superstructure of masonry. The total length of the breakwater is 11,930 feet, its width is 59 feet, in a depth of water from 6½ to 12 fathoms. Some portions of this structure cost £75 11s. per lineal foot, but that part which lies opposite the Lazaret and Arene basins cost up to £109 14s. per lineal foot. This portion runs into a depth of 55¾ feet of water.

ALGIERS.

Harbors protected by rubble mound and concrete block breakwater are at Algiers, Port Said, and Biarritz.

(To be continued.)

STATUE-SURMOUNTED TOWER WITH OSCILLATING BEAM, PROPOSED FOR THE COLUMBIAN EXPOSITION OF 1893.

Designed by OBERLIN SMITH, of Bridgeton, N. J.

THE general idea of this scheme is to make a permanent octagonal tower as in Fig. 1, of severely plain contour, about 600 feet high, surmounted with a sheet metal statue of Columbus about 125 feet high, looking westward. The dome-shaped top would be about 100 feet in diameter, riveted together from plate steel. The posts at each angle of the octagon would be shells of steel plate 10 or 12 feet in diameter, riveted up like a boiler shell, and tapering somewhat toward the top by placing each section inside of the one below. The cross pieces and braces would probably be of channel iron, tee iron, etc. An interior elevator shaft, containing an elevator, might be erected vertically, if desired, in the center. If thought best, a projecting balcony could be arranged around the base of the dome, at or near C.

Pivoted to this tower there would be, during the Exposition at any rate, if not permanently, a huge oscillating beam, as shown in Figs. 2, 3 and 7, swinging after the manner of the walking beam upon a steamboat. Its extreme length would be about 1,100 feet and its width in the center up and down about 150 feet. Its members would be of the same general construction as the tower itself.

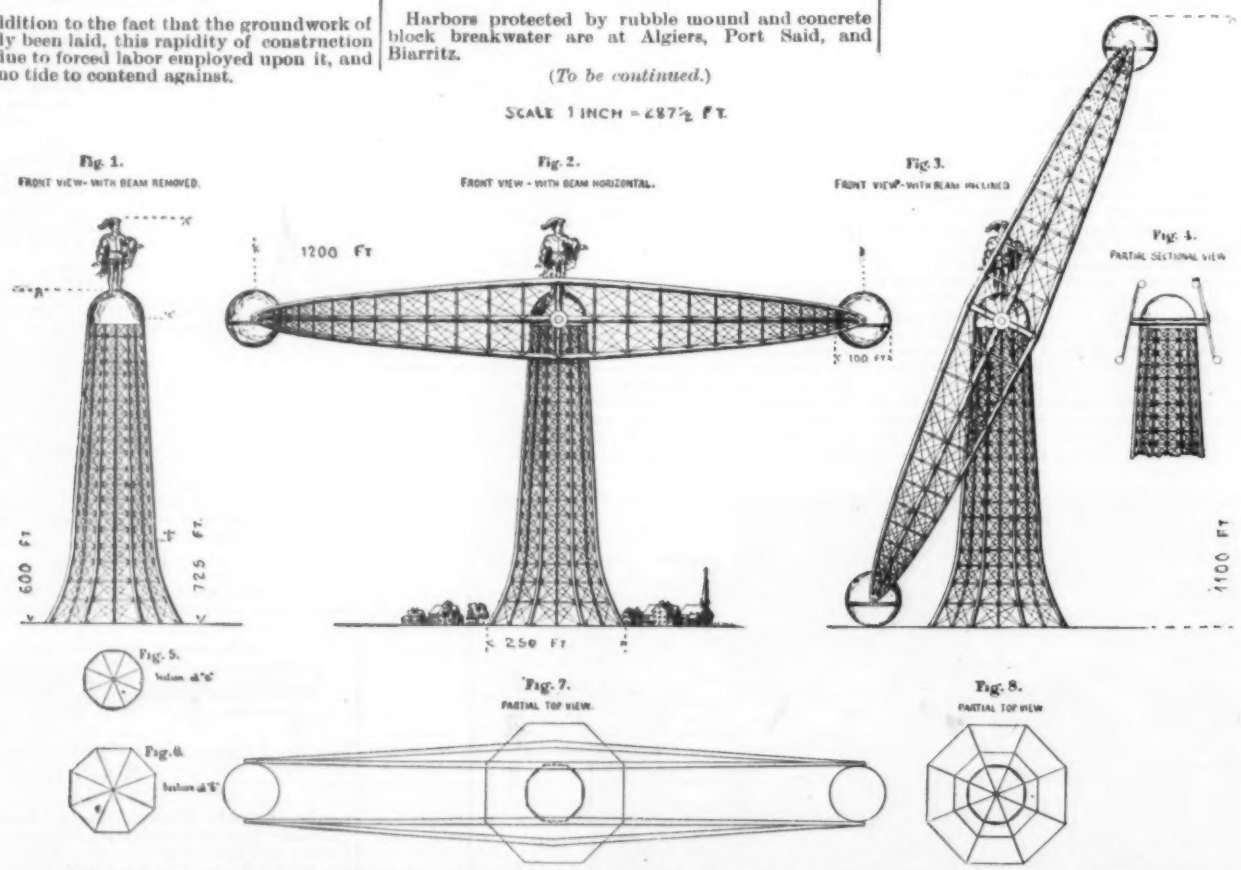
Between each end of this double beam would be a globe of sheet metal, about 100 feet in diameter, with one or more floors inside and rows of windows at a proper distance above them, one such row being shown in Figs. 2 and 3. These spheres would represent the eastern and western worlds respectively, and they might be painted upon the outside, if desired, to represent ordinary terrestrial globes.

Near the bottom of each globe would be doors of ingress and egress through which passengers would pass when one of the globes touched the ground, as in Fig. 3. When loaded, which would take but a few seconds, the beam would be oscillated to the reverse position, starting very slowly, accelerating to quite rapid motion in the middle of its course and gradually slowing again toward the end, thus making the motion perfectly easy, by raising the passengers to a height of 1,100 feet (so as to be higher than the Eiffel tower) in a time probably not to exceed three or four minutes, instead of the thirty or forty minutes which were frequently necessary at Paris; besides having a capacity for many fold the number of passengers—and having the advantage of taking up one load while bringing down the other.

The globes would remain with their floors horizontal by being ballasted at the bottom; but if additional security was thought desirable a system of wire rope cables, extending from one globe to the other, inside the beam, could easily be arranged to keep their vertical axes in absolute parallelism with the vertical axis of the tower.

The beam would probably be moved by two rows of hydraulic cylinders, inside and near the top of the tower, their pistons either pulling by means of wire ropes upon a drum mounted upon the axis of the beam or by racks upon their pistons meshing into spur gears upon the same. The machinery required would thus be very much more simple than in the three systems of elevators used in the Eiffel tower, and the motion of the beam would be entirely controlled by one or two valves in a water pipe running from the ground up to the cylinders. It could of course be made to work automatically, so as to absolutely prevent any undue speed being attained by the beam.

If it was thought best to make the tower and statue

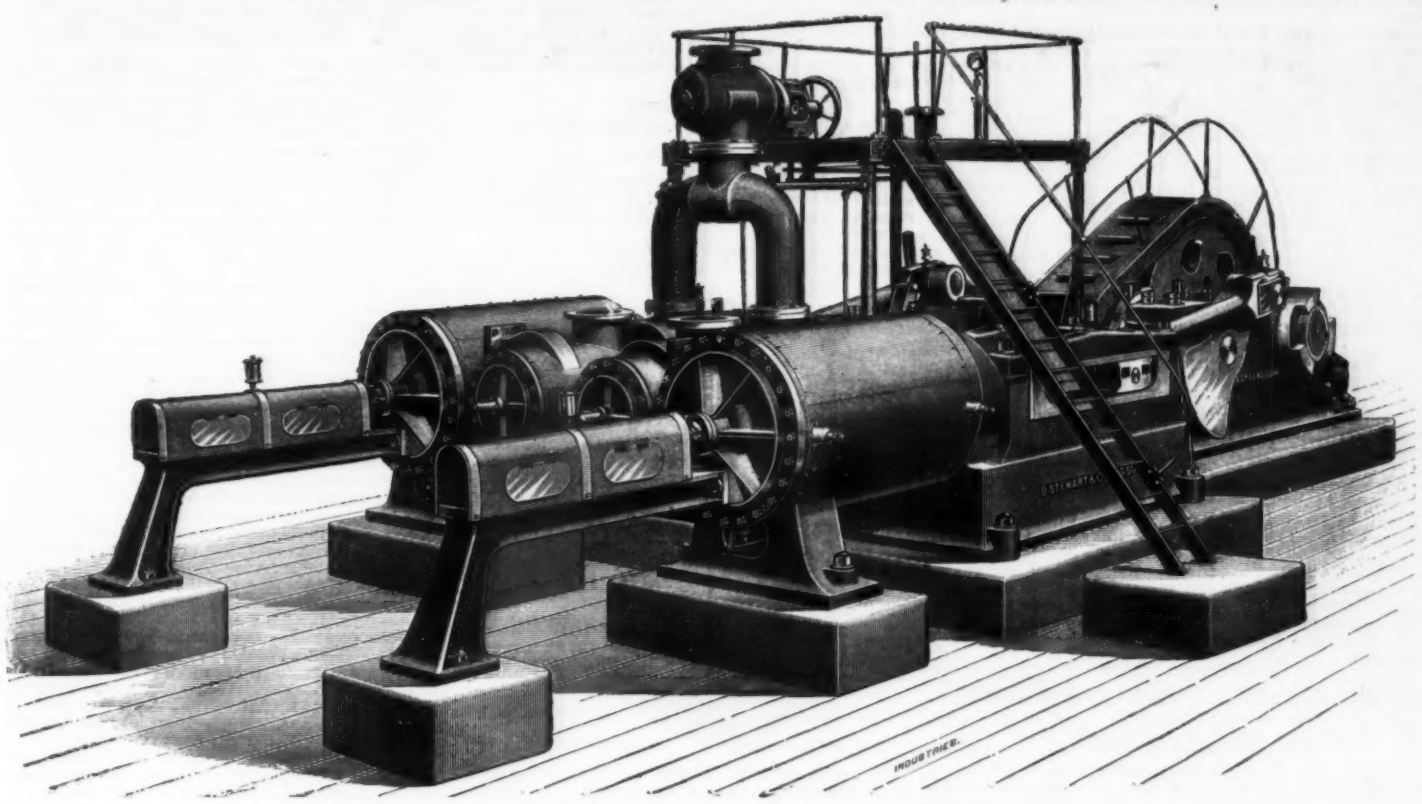


PROPOSED TOWER WITH OSCILLATING BEAM, FOR COLUMBIAN EXPOSITION.

(Construction as shown, approximate only.) Designed by Oberlin Smith, Bridgeton, N. J.

only the permanent part of the structure, the beam could probably be so designed as to be taken down, at a proper interval after the close of the Exposition, and sold, to be put together again as a pair of bridge trusses, in some appropriate situation, where they would make a bridge of beautiful design, with historic associations.

Should it not be financially feasible to complete the statue in time for the Exposition, it could be added afterward as a feature of the permanent tower.



IMPROVED ROLLING MILL ENGINES.

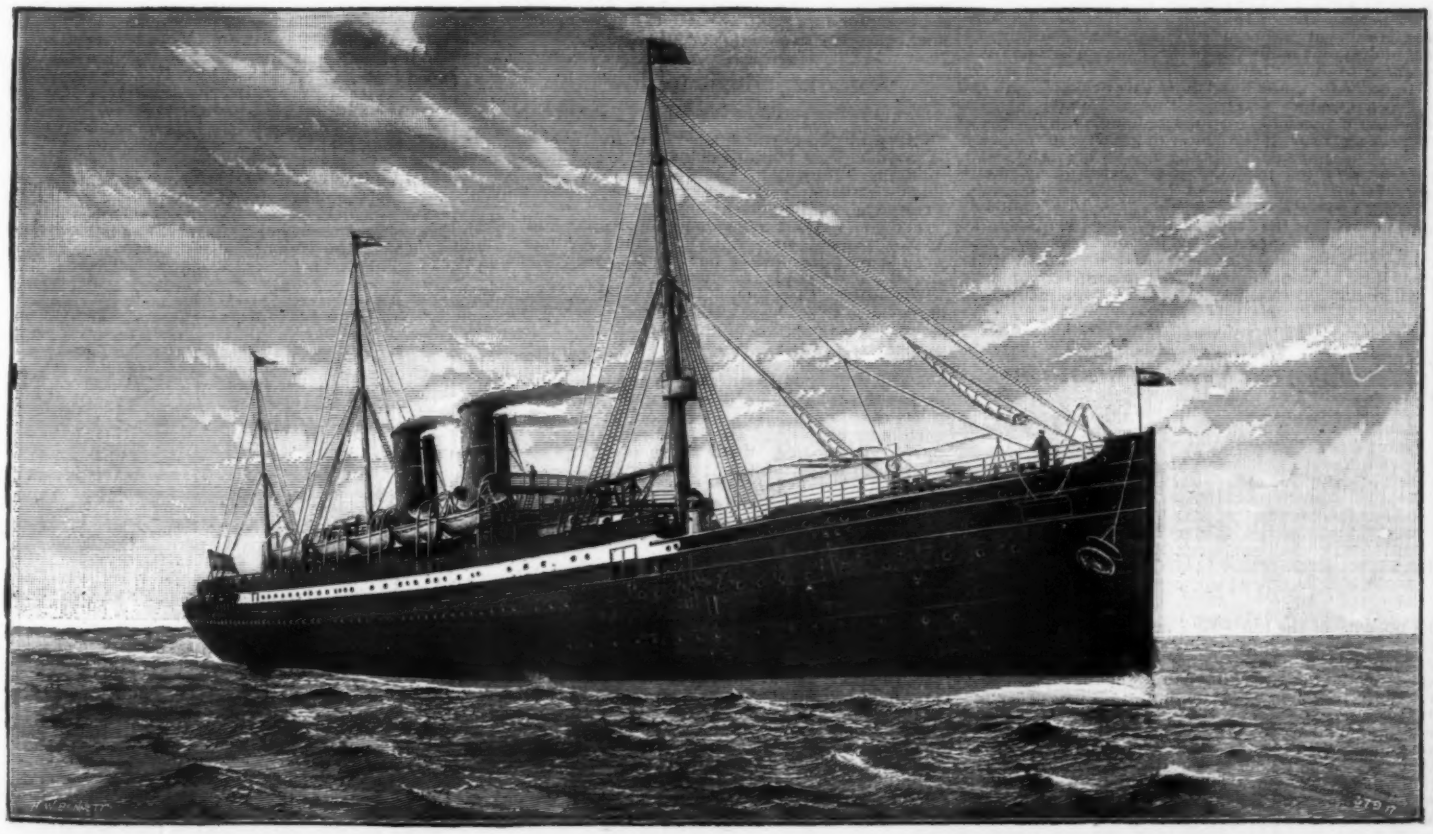
ROLLING MILL ENGINES.

WE give an illustration of a pair of coupled rolling mill engines which Messrs. Duncan Stewart & Co., engineers, Glasgow, have erected at the Parkhead Rolling Mills, Glasgow, of Messrs. W. Beardmore & Co. The diameter of each cylinder is 42 in. and the stroke 5 ft. The piston rods are of steel, and are 6¼ in. diameter at the front and 4½ in. diameter at the back ends, where they are carried by guides. The connecting rods are of steel, and are 13 ft. 6 in. between centers in length, with a straight taper from 7¼ in. diameter at the crosshead end to 8½ in. diameter at the crank pin end. The steel crosshead pins are 8¼ in. diameter and 9¼ in. long, and the steel crank pins are 9 in. diameter and 10 in. long. The cranks are of cast steel and balanced in an efficient manner. The crank shaft is of steel, and has journals 16 in. diameter by 24 in. long. The body of the shaft is 18 in. in diameter, but is increased to 19 in. diameter at the middle, where it receives a helical steel pinion 3 ft. 7 in. diameter, having eighteen teeth, 24 in. broad and 7½ in. pitch. The pinion gears with a spur wheel 8 ft. 11½ in. diameter, having forty-five teeth. The center of the spur wheel is of cast iron, and is fixed to a steel rim by means of hard wood wedges. The large wheel is carried upon a steel shaft having journals 17 in. diameter and 24 in. long. The body of this shaft is 19 in. diameter, but increased to 20 in. at the middle, where it receives the spur wheel.

The engines are fitted with piston valves, which work in separate valve casings bolted to the side of the cylinders. The steel valve spindles are 3 in. in diameter. The eccentric rods are flat, bolted to cast iron eccentric straps. The eccentrics are of cast iron, and have ample bearing surfaces. The link motion is operated by means of a reversing engine, which is simple but efficient, and has been specially designed for the purpose by the makers. The sole plate for each engine is cast in one piece, and is of a very strong design. These engines have been working for some time and are giving every satisfaction.—*Industries.*

THE NORTH GERMAN LLOYD STEAMER SPREE.

THE Spree and Havel, of which sister vessels we give an engraving, for which we are indebted to *Engineering*, are the latest additions to the great fleet of the company known as the North German Lloyd. Besides 76 ocean-going steamers of various size and power, totaling 169,394 tons, they have 60 lighters of 11,502 tons burden, the entire fleet including 136 vessels of 180,896 tons, with engines of 156,355 horse power. The Spree and Havel are the largest of the North German Lloyd steamers. The following are the principal dimensions: Length, 485 ft.; breadth, 52 ft.; depth moulded, 38 ft., and gross tonnage 6,963 tons. There are five decks, the forecastle and poop with a bridge deck, three-fourths the length of the vessel, forming the promenade deck, on which there are a number of first class state rooms and several of the public rooms. On the upper deck forward is the dining saloon, which occupies the whole width of the ship. There are in the center of the ship state rooms for 244 first class passengers, several being suits of rooms for families. The second class rooms abaft the machinery accommodate 122 passengers, while in the extreme ends and on the lower deck 460 steerage passengers may be carried. The crew numbers 240, so that in all the vessel has ac-



THE NORTH GERMAN LLOYD STEAMER SPREE.

commodation for 1,066. There are twelve water-tight transverse bulkheads, so that on an average every 40 ft. of the ship is a separate compartment, and there are double bottoms, with cellular spaces between for water ballast. On each steamer ten steel lifeboats and several semicollapsible boats are carried, all above and therefore clear of the promenading space. The current for electric lighting is maintained by four dynamos, each capable of running 350 incandescent lamps of 25 candle power.

In the Spree and Havel the contract indicated horse power was 12,500. In their case the company have again introduced five cylinders as in the case of the Lahn, a design of engine by Mr. Andrew Laing, the engineering manager at Fairfield. It enables great power to be developed, while the size of cylinders is not excessive. There are two high pressure cylinders 38 inches in diameter, one intermediate 75 in. in diameter, and two low-pressure 100 in. in diameter, the stroke of piston in each case being 6 ft. The intermediate is in the center, with a high pressure and low pressure at each side, the former above the latter. Steam is supplied from ten boilers, each 15½ ft. in diameter. Six are double ended 18 ft. 8 in. long, and four single ended 10 ft. 4 in. long. They are constructed of steel, and work at 165 lb. pressure. The propeller is of manganese bronze, has four blades, the diameter of the screw being 21 ft. 7 in. and the pitch 31 ft. 4 in. On her trial in the Baltic the Spree had a mean speed of 19·6 knots. The highest speed attained was 20·1, the engines developing 13,000 indicated horse power at 70 revolutions. She commenced service in October last, and the sister ship, the Havel, commenced in the beginning of the year. Neither vessel has been worked up to her full power, so that as yet there has been little record breaking. The Lahn has still the best record of the fleet for the outward voyage, but the Spree beat that vessel by two hours in the homeward voyage.

The Spree has come home in 6 days 21½ hours. The distance steamed being 3,067 knots, her speed averaged 18·55 knots. Her complete day's runs were 424, 437, 438, 423, 416, 448, and 427 knots to the Needles; and the log shows rough seas on the second, fourth, and fifth days.

The average number of knots steamed between Sandy Hook and Needles out and home is estimated at 3 080 knots.

HENRY'S ELECTRIC MOTOR CONSTRUCTED IN 1831.

By J. ELFRETH WATKINS.

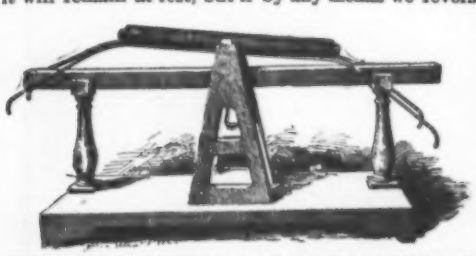
ONE of the most interesting objects displayed in the loan collection of mechanical relics, etc., exhibited in the lecture hall of the United States National Museum at Washington, during the patent centennial celebration, was the original electro-magnetic engine designed by Joseph Henry in 1831, and constructed with his own hands. This machine, simple as it is, is one of the earliest applications of magneto-electricity to the production of power. Henry calls it "reciprocating motion produced by magnetic attraction and repulsion." In July, 1831, writing to the editor of *Silliman's Journal*, he says:

"I have lately succeeded in producing motion in a little machine by a power which, I believe, has never before been applied in mechanics—by magnetic attraction and repulsion.

"Not much importance, however, is attached to the invention, since the article, in its present state, can only be considered a philosophical toy, although in the discovery and invention it is not impossible that the same principle, or some modification of it on a more extended scale, may hereafter be applied to some useful purpose. But without reference to its practical utility, and only viewed as a new effect produced by one of the most mysterious agents of nature, you will not, perhaps, think the following account of it unworthy of a place in the *Journal of Science*.

"It is well known that an attractive or repulsive force is exerted between two magnets, according as poles of different names, or poles of the same name, are presented to each other.

"In order to understand how this principle can be applied to produce a reciprocating motion, let us suppose a bar magnet to be supported horizontally on an axis passing through the center of gravity, in precisely the same manner as a dipping needle is poised; and suppose two other magnets to be placed perpendicularly, one under each pole of the horizontal magnet, and a little below it, with their north poles uppermost; then it is evident that the south pole of the horizontal magnet will be attracted by the north pole of one of the perpendicular magnets, and its north pole repelled by the north pole of the other; in this state it will remain at rest, but if by any means we reverse



HENRY'S ELECTRIC MOTOR CONSTRUCTED IN 1831.

the polarity of the horizontal magnet, its position will be changed and the extremity, which was before attracted, will now be repelled; if the polarity be again reversed, the position will again be changed, and so on indefinitely. To produce, therefore, a continued vibration, it is only necessary to introduce into this arrangement some means by which the polarity of the horizontal magnet can be instantly changed, and that too by a cause which shall be put in operation by the motion of the magnet itself; how this can be effected will not be difficult to conceive, when I mention that instead of a permanent steel magnet in the movable part of the apparatus, a soft iron galvanic magnet is used.

"The motion, here described, is entirely distinct from that produced by the electro-magnetic combination of wires and magnets; it results directly from the mechanical action of ordinary magnetism, galvanism being only introduced for the purpose of changing the poles."

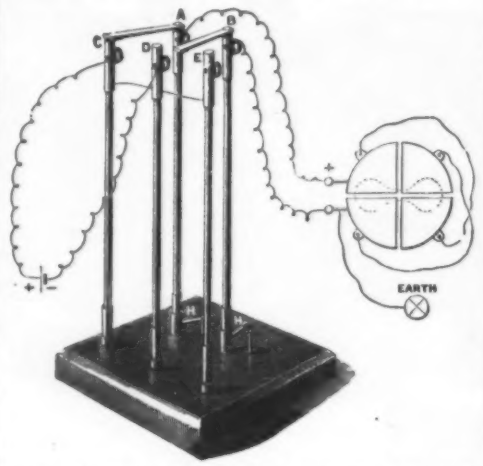
At the end of sixty years the same principle that led the great physicist (who is known to the world as a discoverer rather than an inventor) to make this "little machine" is used in constructing the electrical devices which may properly be classed among the mechanical triumphs of the century of invention which have been indelibly recorded in the annals of our history by the recent patent centennial celebration.—*Electrical World.*

AN ELECTROSTATIC COMMUTATOR.

By ROLLO APPLEYARD.

THE electrostatic commutator here shown is a simple apparatus, of small capacity and high insulation, for effecting all the ordinary connecting operations with electrometers.

It consists of five insulating rods, three of which, C, D, E, are fixed; A and B are fitted into brass sockets



in the baseboard with spring washers, so as to be capable of turning about a vertical axis by handles, H.

At the top of each fixed rod is a binding screw, tipped with platinum, and having a slightly convex surface of contact.

The rods, A, B, carry contact springs with corresponding hollows at their rubbing ends, so that when handle is moved the spring slides on and drops into place easily.

The screws, C and E, are connected permanently together by a wire.

A and B are the quadrant terminals; D, and either C or E, are for the test wires. This method of connecting prevents all possible chance of short-circuiting a cell under test. By sliding the springs on to C and D, the quadrant in connection with A becomes +, and that joined to B is −. We may reverse by sliding the springs to D and E respectively.

The electrometer quadrants are connected together by joining A to C and B to E—in which position the springs should always be left after a test.

In intermediate positions the quadrants are completely insulated. When very high insulation is required, some desiccating arrangement may be employed. With a slight modification of the handles, a place might be found for this commutator inside the electromotor case itself, the handles being entirely outside, below the base.—*Electrical Review.*

ON THE CORROSION OF IRON.

By ROBERT IRVINE, F.C.S., F.R.S.E.

THIS may well be called the "Iron Age," for it would be as difficult to point to any structure or mechanical appliance from which iron is absent as it would be tedious to enumerate the multitudinous uses in which it is employed at the present day.

In olden times it was valued above gold and silver. At the present time its initial value is a mere trifle (even in its purer forms), but its true value lies in its almost universal adaptability.

The subject, therefore, of its corrosion is of such vast importance that I have gathered together a few *out of the common* instances of the destruction of its useful properties.

The processes of smelting deprive the ore of the oxygen and other bodies with which the iron is combined, and at the same time add to its impurities, which make it less able to withstand corrosion, subsequent fusion with basic bodies and air being necessary to deprive it of these impurities. Curiously enough, cast iron is less subject to oxidation than the purified wrought iron or steel. This is in part due to the silicious skin formed by the combination of the molten iron with the sand of the mould.

Their comparative liability to oxidation, according to Mallet, is as follows:

Cast iron	100
Wrought iron	129
Steel	133

According to Gmelin the purest iron rusts most quickly, and the presence of sulphur and iron accelerates the rusting, while phosphorus seems to retard it. It is only when exposed to damp air containing carbonic acid that rusting or oxidation takes place, due, according to Calvert's observation, to galvanic action, protoxide, and subsequently carbonate of the protoxide, being formed, which in turn is changed to sesquioxide by the absorption of oxygen; ammonia being at the same time formed from the nascent hydrogen of the decomposed water and the nitrogen of the air.

A second form of corrosion is familiar to us when iron is exposed to the smoke of cities containing a large proportion of sulphurous and carbonic acids, which, forming soluble salts with the iron, are removed by water. Sea water, on account of the quantity of magnesium salts and carbonic acid present, has a powerful solvent action on cast and wrought iron. Besides this, when iron is exposed to the action of sea water in the presence of dead or decomposing organic matter, owing to its well known action in the deoxidation of alkaline and earthy sulphates,

$$MSO_4 + 2\,C = 2\,CO_2 + MS$$
$$MS + CO_2 + H_2O = M_2CO_3 + H_2S,$$

sulphide of iron is produced. A familiar example of this process occurs in the muds of tidal rivers and harbors, the iron present in the clay combining with the liberated sulphur to form sulphide of iron, and we may assume from this source most of the iron pyrites deposits take their origin.

A typical instance of this kind of corrosion came under my notice when removing an iron chain which had been used as a mooring in sea water. When taken from the water it was thickly coated with living and dead animals. The sulphur from the deoxidized sulphates had combined with the metallic iron to form a skin fully an eighth part of an inch in thickness, and the chain was correspondingly weakened to this extent.

Of another form of the corrosion of iron, evidently due to galvanic action set up between two forms of the same metal, we have many instances. In one case the pans in which crude saltpeter was dissolved were made of cast, while the steam pipes and stirrers were made of wrought iron. The cast iron was unaffected, but in a short time it was found the wrought iron fittings had become so corroded or wasted away that they had to be replaced. On cast iron pipes and fittings being substituted the corrosion ceased.

Again, wrought iron boilers in combination with cast iron pipes are used for heating purposes. The boiler is rapidly wasted away and rendered useless. In the same manner the cast iron fittings of the steam boiler tend to corrode the portion of the malleable iron upon which they are fixed.

In the fitting of propellers for steam vessels the former are usually made of cast and the tunnel shaft of malleable iron. After a time the propeller becomes loose on account of the combination of the two unlike metals causing corrosion of the same nature.

When malleable iron rails are fixed in iron sleepers, as on our railways, the corrosion of the weaker metal is very apparent. The serious nature of this action is exemplified in the following extract from *Engineering* of December, 1890:

"An important fact in regard to the wear of railway rails is notified and illustrated in the last number of the *Engineer*. Two sections of the same rail are given showing the comparative wear of the rail, in a period of seven years, in a tunnel and on the open railway. The difference is very remarkable. The rail laid in the tunnel has lost nearly half the area of the lower flange, the rounded extremities are pared down to knife edges, and about one quarter of the area of the upper flange is eaten away, more on one side than the other, leaving an irregular shaped mass. This alarming increased wear and disintegration in the tunnel is, of course, due to atmospheric causes; but if this case is taken as establishing the general tendency of rails to behave in this way in tunnels, it is a fact of serious importance in regard to the laying and maintenance of tunnel roads. A tunnel is exactly the place where one may suppose that a defective condition of the rails might most easily escape observation; yet it appears that this is where it is most likely to occur within a given space of time."

The "atmospheric causes" here clearly point to this example of corrosion as of the same catagory as those already mentioned.

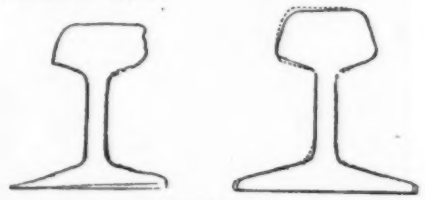
In connection with this subject it is abundantly manifest that the use of two dissimilar forms or kinds of iron becomes a source of danger and loss.

If plates of cast and malleable iron are placed in water, and wires from each connected with a galvanometer, deflection of the needle at once takes place, while if both plates be either of cast or malleable iron no galvanic action ensues.

It naturally follows that any structure, if it is to be free from the danger I have referred to, should be composed of the same variety of iron; and by observing this matter (although a very simple rule), the constructors of the Forth Bridge, where mild steel was used throughout in its construction, have doubtless avoided the mistake made in the construction of the old Tay Bridge, which was a combination of cast and malleable iron, neither being of very good quality. After its destruction, the commission appointed by government

Fig. 1.
Loss 26 per cent., reduced to 49½ lb.

Fig. 2.
67 lb.



67 LB. RAILS.

Fig. 1.—Laid in tunnel six years
Fig. 2.—Laid outside tunnel six years
} Both exposed to same traffic, wear, and tear.

Musconetcong tunnel, Lehigh Valley Railway, near New York. From *Engineer*, 1890, p. 539.

to inquire into the cause of its collapse found that the rivets of the malleable iron portion had become loosened, and the evidence all pointed in the direction that this bridge was so constructed that it formed a huge galvanic circle in which the malleable iron was weakened beyond the point of stability.

The universal use of paint in the preservation of such structures is well known, but I consider the use of all metallic pigments has a tendency, wherever the iron is not thoroughly covered, to provoke the danger they are intended to remedy.

A varnish such as boiled linseed oil alone, which, on exposure to air, dries up into a tenacious elastic coating, seems to me to be the proper material to be used for the protection of iron structures.—*Jour. Soc. Chem. Industry.*

INSIGNIA OF OFFICERS' RANK IN THE NAVY

THERE are probably very few men in civilian life who can distinguish an admiral from a lieutenant by the uniforms they wear. Even men who are well informed on the details of army dress are usually ignorant of the signs that indicate rank in the navy, and there probably is not a single naval demonstration where nine officers out of ten are not confounded by the great majority of the spectators. The same principles that underlie the army insignia are also present, however, in those of the navy. The story of the way in which these came into being is picturesque. It is alleged that the choosing of the marks of rank in army and navy was left to some of the leading ladies of the country after the revolution. Martha Washington was said to have been the originator of some of the devices. At all events the whole world was drawn upon for suggestions and contributions. The heavens were selected to contribute the devices for the highest grades of rank. From them came the stars, most coveted by men in army and navy, and descending to earth the eagle, because of its courage and lofty flight, came next. The oak tree, being noble in proportions and emblematic of strength, furnished its leaves for lesser ranks. The anchor, being distinctive of the navy, was used to indicate it specially, and silver was selected to rank above gold, because it usually lies nearer the surface.

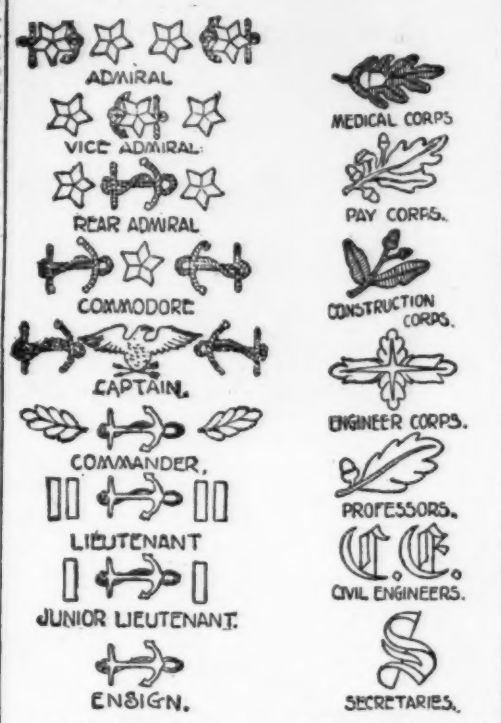
Whatever truth there may be in this legend, it is firmly believed by most of the tars that uphold our flag on the high seas. The person who thoroughly understands the marks of rank in the navy can tell at a glance not only what place the tar holds, but even in many instances what special work is assigned to him. In the company of such a person a walk through the navy yard is highly interesting as well as instructive. In the first place, he tells you, there are four classes of officers in the navy, and each is designated by a special set of devices. First come the commissioned officers of the line, then the commissioned corps officers, then the warrant officers, and, finally, the petty officers. In the first two grades are the Annapolis graduates and officers regularly commissioned by the President and Senate. The third and fourth are made up of enlisted men who have been promoted.

As you stroll through the navy yard with your guide a man comes before you who is evidently an officer of importance. You can see that by the dignity and gravity of his demeanor and the respectfulness of the salutes of the sentinels on guard. If you were offered a million dollars you couldn't tell his rank unless you were a good guesser. It is perfectly plain, says your guide, that this officer is a rear admiral. His collar is decorated with two silver stars with a silver fouled anchor between them. The signs of his rank are on his collar, because he is not in full dress; if he were, they would be on his shoulder knots, but shoulder knots are not worn except in full dress. Were he to become an admiral, he would wear four silver stars with a gold fouled anchor under the two outer stars. If he were a vice-admiral his rank would be indicated by three silver stars with a gold fouled anchor under the center star.

If it happens that your visit is on a day when many of the officers and men are in the yard, you will presently come upon a commodore, and your friend will point out the fact that he has only one silver star with a silver fouled anchor on either side. If you board a ship and are taken before the captain, you will see that he has no stars on his collar, but a silver spread eagle in the center, with a silver fouled anchor at either side. By this time your own observation will probably have become so sharpened that you will be able to make out the devices at a glance and will simply have to ask the rank of the man whose device is different from any that you have seen. When you see an officer with a silver oak leaf on either side of a silver fouled anchor, your friend will tell you that he is a commander, and when you see the same device in gold instead of silver, you will learn that the officer who wears it is a lieutenant commander. Perhaps now you will be able to comprehend, through the explanations of your friend, the other devices used in the navy without seeing them. This will be what he will tell you:

Lieutenants are indicated by the device formed by two silver bars on either side of a silver fouled anchor. If they are in the junior grade they have one silver bar instead of two. Ensigns have only a silver fouled anchor, and naval cadets, after a four years' course at Annapolis, wear the same device in gold. The same devices worn by the above, who are line officers, are also worn by the corps officers on their epaulets or the center of their shoulder straps, but the latter wear in addition certain devices to denote their corps or department. Officers of the medical corps wear a spread oak leaf in gold with a silver acorn thereon. Officers of the pay corps are distinguished by the silver oak spray. Those in the engineer corps wear four silver oak leaves combined at the stems. Officers in the construction corps have a gold sprig of oak leaves and acorn. Professors have one silver leaf and acorn. Civil engineers have the letters C. E. in silver, and secretaries are denoted by the letter S. in silver.

Warrant officers wear their rank devices on their coat sleeve, above the elbow. The boatswain, gunner, carpenter and sailmaker, mate and pay clerk have devices in gold; all other warrant officers wear them in silver after a service of twenty years in the rank. The boatswain's rank is indicated by two anchors crossed. The sailmaker wears a spread sail, the mate a pair of field glasses, and the pay clerk an oak leaf with acorns. Among the petty officers there are three classes. The eagle appears on first, second and third class marks. A little diamond between the eagle and a chevron denotes first class. An eagle without the diamond and three stripes in the chevron indicate second class. An eagle and two stripes in the chevron denote third class. Even among the petty officers each has his distinctive device. The master at arms and ship's corporal wear a star. The chief quartermaster and quartermaster's mate wear a wheel. The seaman gunner has something that looks like an exploding bomb. The apothecary wears a staff similar to that borne by Mercury. The chief boatswain, boatswain's mate, captain of top, captain of after guard or coxswains, wear two anchors crossed. The chief gunner's mate and armorer wear two cannon crossed. The yeoman and captain of the hold wear two keys crossed. The ship's writer wears two quill pens crossed, and the schoolmaster and printer have a book. The ship's cook has a life buoy.



LINE OFFICERS. CORPS OFFICERS.

The carpenter's mate, blacksmith and painter have two axes crossed. The sailmaker's mate has an eye, the machinists, boiler makers and water tenders have a propeller screw. The bandmaster and chief musician have a harp, and the apprentice and graduate have a coil of rope. The seaman's class is indicated by rows of braid on the cuff or collar. A seaman of the first class has three rows; second class, two rows; third, one row.

When a petty officer has been especially good and has received three good conduct badges, he is allowed to wear a gold chevron, otherwise it is always red.

WARRANT OFFICERS. PETTY OFFICERS.

Specialty marks and the eagle are in white on blue cloth, and blue when on white cloth. The graduate's apprentice mark is worn on the cuff of a warrant officer's coat and on the breast of a seaman or petty officer. The master-at-arms wears a chevron of three stripes and an arch of three stripes with the eagle over a star on the latter. He is the only petty officer that wears an arched chevron. If you see a petty officer with his device on his left arm, you must know that his is the port watch. If his device is on his right arm, that indicates that he has a starboard watch. The seaman's watch is denoted by a white stripe on the shoulder. If it is on his left shoulder, he is a port watchman; if on the right shoulder, he is a starboard watchman. If he wears a red stripe on his shoulder, it indicates that he is in the fire or engine room.—*N. Y. Sun.*

THE INTENSIFICATION OF NEGATIVES.*

IN presenting to the Society this evening these few notes on intensification, it is not my intention to offer anything new, but merely to call attention to some of the most important details of an old and well known process, namely, that with mercury and sodium sulphite.

It has been tacitly considered by many photographers that the practice of intensification is a rather reprehensible one, and not to be depended upon for satisfactory results. Yet it should be an orthodox and thoroughly reliable method of procedure. In the days of wet plate photography, intensification with acid pyro and silver was a routine part of the process; now, in the days of rapid plates and thin, soft negatives, full of detail but lacking in density, a reliable method of intensification is just as much of a necessity, and often required.

The following method, therefore, many of the details of which were elaborated by Mr. John Bartlett (a member of this society), can be depended upon to give certain and satisfactory results in every case. The details are as follows:

The negative (film or glass) should, after fixation, be thoroughly washed and then dried. The dry negative is then placed in a suitable dish, film side up, covered with clean water, the face swabbed over thoroughly with a tuft of absorbent cotton to remove air bubbles, allowed to soak for a few minutes, and then the water poured off, and sufficient of the following solution poured on to cover the plate. The solution is composed of—

Citric acid	60 grains.
Perchloride iron (dry)	60 "
Water	1 pint.

This is kept in constant agitation over the plate for about a minute, and then returned to its bottle, and the plate washed under a running stream of water for about five minutes. This solution can be used repeatedly for a long time before becoming exhausted. Its use is twofold—it tends to remove any thin film of fog upon the surface of the negative, and also furnishes a groundwork for the subsequent deposit of mercury. The plate is now bleached by being placed in the following solution:

Mercury bichloride	¼ ounce.
Common salt	½ "
Water	1 pint.

The plate must be frequently rocked while in this solution, and allowed to remain in it until sufficiently bleached. This is regulated by the amount of intensification required. If considerable density is desired, it must be allowed to remain until quite white. This solution is then to be poured off, and can be either thrown away or used for several more plates; the best results are obtained, however, by using fresh solution for each negative. The plate is next covered with a sufficient quantity of the following solution:

Common salt	2 ounces.
Water	2 pints.

This is allowed to remain on the plate for about a minute, then poured off and thrown away, and the plate well washed under the tap for about five minutes. The object of the salt is simply to dissolve out any mercuric chloride remaining in the film, and prevents the clear portions of the negative from becoming clogged up with any reduced mercury in the next operation. The plate is now returned to the dish, and a sufficient quantity of the reducing solution poured on it to just cover it. This is made as follows:

Sodium sulphite, cryst	3 ounces.
Acid sulphuric, conc	2 *f* drs.,
or ½ ounce by weight.	
Water	1 pint.

The sulphite is dissolved in twelve ounces of water, allowed to cool, and then the acid, previously mixed with four ounces of water, added. I should say just here to those not familiar with chemical manipulation, that in mixing sulphuric acid and water the acid should always be poured gently and in small quantities into the water, not the water added to the acid, as in the latter case, owing to the violence and heat of the combination, some of the acid might be thrown in the face of the operator.

As soon as the reducing solution is poured on the plate it commences to turn brown and then black. The operation is completed when the *back* of the plate is perfectly dark, showing no traces anywhere of the whiteness caused by the mercury. The negative should then be perfectly bright and clear, and of a brilliant bluish black color. It is then to be placed under the tap, washed for five or ten minutes to free it from all traces of sulphite, swabbed off with a piece of cotton, and set up in a rack to drain or dry. The reducing solution can be used several times until it becomes exhausted, and is then thrown away. It should never be returned to the original stock bottle. This process can be depended upon to yield in every case good, satisfactory results, and the intensification produced is perfectly permanent in character. The main points to which attention must be directed in order to secure good results are these:

1. All solutions used must be filtered, clear and free from specks.

2. The negative must have been previously *well washed*, so as to *thoroughly remove all traces of hypo.*

3. The negative must be moistened before the solutions are poured on, so that they will act evenly and uniformly on the plate.

A negative can, if necessary, be intensified immediately after development, fixation, and washing, without being allowed to dry, but in this case the density obtained will not be so great as if the plate had been previously dried. CHARLES L. MITCHELL, M.D.

* Read before the Photographic Society of Philadelphia.

AUTOMATIC PHOTOGRAPHY.

THE first idea of applying automatic apparatus to photography is due to a Spaniard, Mr. Juan Canto, and, although recent, this invention appears to have now reached a degree of perfection sufficient to allow it to find an application in the domain of practice. The apparatus devised by Mr. Canto, and patented December 31, 1887, was constructed by Mr. Mallet, at

FIG. 1.—ENJALBERT PHOTOGRAPHIC APPARATUS.

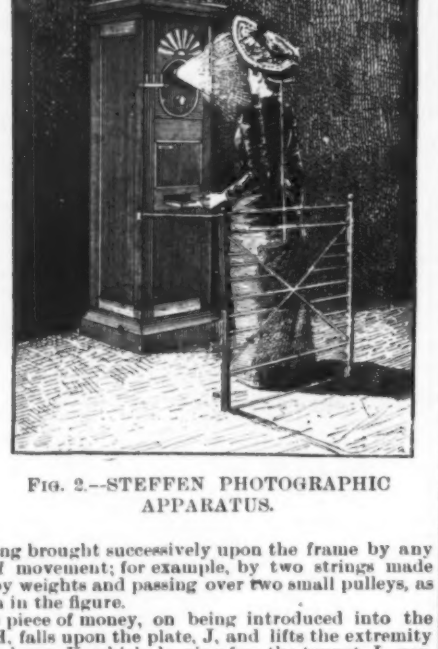


FIG. 2.—STEFFEN PHOTOGRAPHIC APPARATUS.

Paris, but did not give the results anticipated by its inventor. One of Mr. Mallet's workmen, Mr. Zacco, and one of his employes, Mr. Duran, took up the first idea on their own account, and, with the concurrence of Mr. Isaac Joel, succeeded in forming a company with a capital of several million francs for the exploitation of an improved apparatus, to which they adapted the Cheron & Feret process of development. This tentative had no better outcome. On his side, Mr. Canto, continuing his researches, finally succeeded, with the aid of Mr. Touffreville, in devising a new apparatus, which operates very well.

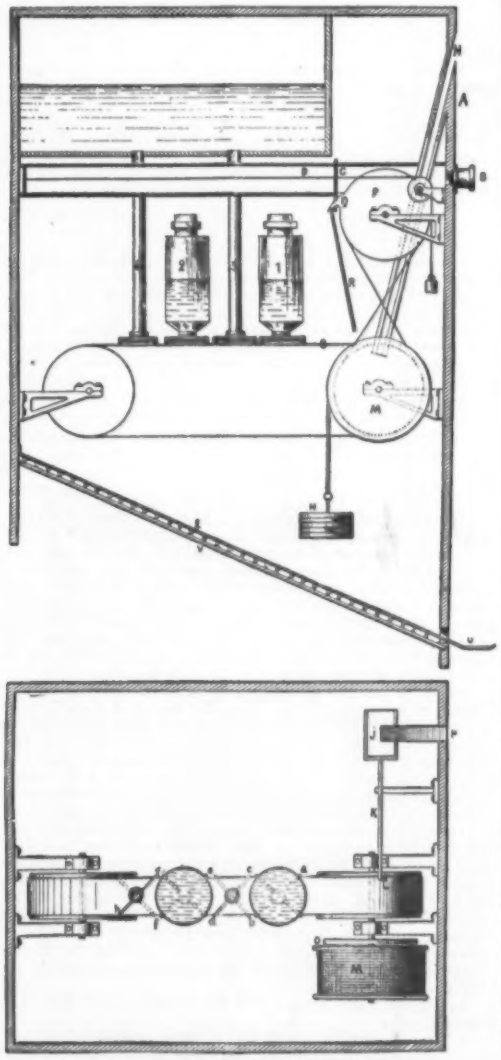


FIG. 3.—CANTO APPARATUS.

Another inventor, Mr. Enjalbert, in 1889, exhibited an apparatus based upon a different system, and which, since improved, has recently been installed at the Paris Casino, where it has met with merited success. We shall not try to give our readers a complete description of these ingenious apparatus, but it has appeared to us of interest to show the working of Mr. Canto's first apparatus and that of the Enjalbert apparatus, such as we now have it, and afterward briefly to describe the other systems hitherto proposed, and which all have more or less analogy with the first.

The Canto apparatus (Fig. 3) consists of a case, A, to which is fixed an objective, B, behind which, at a proper distance, there is a frame, C, closed by a shutter, and which carries the photographic plate. A number of duplicate plates placed parallel in a box are capable of being brought successively upon the frame by any sort of movement; for example, by two strings made taut by weights and passing over two small pulleys, as shown in the figure.

The piece of money, on being introduced into the slot, H, falls upon the plate, J, and lifts the extremity of the lever, K, which, leaving free the tappet, L, permits the drum, M, to assume a rotary motion under the action of the counterpoise, N.

The pulley, O, mounted upon the same axis, is carried along in this motion and transmits the rotation to the pulley, P, that carries a cam which acts upon the tooth, Q, of the shutter and causes it to rise. The plate, being thus exposed, is acted upon by the light. It descends at the moment that the shutter drops, and, through the inclined plane, R, reaches the endless band, S, which moves from right to left under the action of the drum and carries the plate successively under the bottles, 1 and 2, and the water pipes, 3 and 4. The tappet, L, moving with the endless band, touches the lever, *a b*, causes it to turn and brings it to a perpendicular position.

The developing liquid contained in bottle, 1, flows upon the plate until a second tappet fixed upon the endless band, but not shown in our engraving, abuts against the lever and brings it to its first position. In the same way, and in succession, are obtained the opening and closing of the pipe, 3, the bottle, 2, and the pipe, 4, by means of the levers, *c d*, *e f*, and *g h*. The water is furnished by a small reservoir, F. After the plate has been fixed and washed, it descends upon the inclined plane, E, under which is installed a gas pipe, and whereon the plate is dried before reaching the shelf, U, whence the owner takes it.

As we have already said, this apparatus has not given satisfactory results upon trial. The following is the modification made by Mr. Touffreville to remedy the imperfections of the first model. The plates are placed upon top of one another in a box closed at the bottom by a drawer. The mechanism is not very different from that described above. We have again a clockwork movement held at rest by a tappet. As soon as the coin is dropped into the slot, it falls upon a plate fixed at the extremity of a lever which carries the tappet that arrests the motion of the clockwork. This tappet frees the driving wheel, which, under the action of a weight, makes a complete revolution. The plate lying in the drawer is pushed forward by a rod and falls into a conical hopper, which leads it vertically to the rear of the objective. The rod afterward moves the drawer back to its first position and a new plate takes the place of the first. During this time, a lever actuated by a gear wheel fixed upon the motive shaft causes the shutter to rise.

The plate having been acted upon, the shutter drops, and the plate enters a tray in which the operations of developing and fixing are to be effected. This tray is actuated by a disk mounted upon the motive shaft and carrying a series of projections and undulations—the latter producing the agitation of the tray, and the former causing it to tilt.

The liquids are inclosed in bottles terminating beneath in valves, the opening of which is effected by means of pins arranged upon the external face of the disk of which we have just spoken.

The first pin causes a certain quantity of developing liquid to fall into the tray. The disk, owing to its undulations, agitates the tray until a projection tilts it.

The liquid falls into a reservoir beneath and the tray resumes its horizontal position, while the second pin, acting upon the valve of the second bottle, permits a certain quantity of water to escape into the tray. The same operations are repeated for the fixing liquid and the water of the second washing. The last pin causes the tray to turn nearly upside down, so as to cause the plate to fall upon an inclined plane, down which it slides to the exterior of the apparatus.

The Enjalbert apparatus, represented in Figs. 1, 4 and 5, is based upon an entirely different principle. It utilizes a process known under the name of ferrotype, which consists in taking the picture upon a very thin sheet iron plate covered with a thin coat of varnish. It is therefore necessary that the plate, on coming from the box, A, shall be first covered with collodion and then be immersed in a silver bath. The following operations—developing and fixing—are the same as in the preceding apparatus. The apparatus is therefore necessarily more complicated; but it must be admitted that, such as it is, it may pass for a true masterpiece of ingenuity. The entire mechanism is here actuated by electricity produced by batteries or accumulators placed in the base of the apparatus.

The apparatus is divided by vertical partitions into

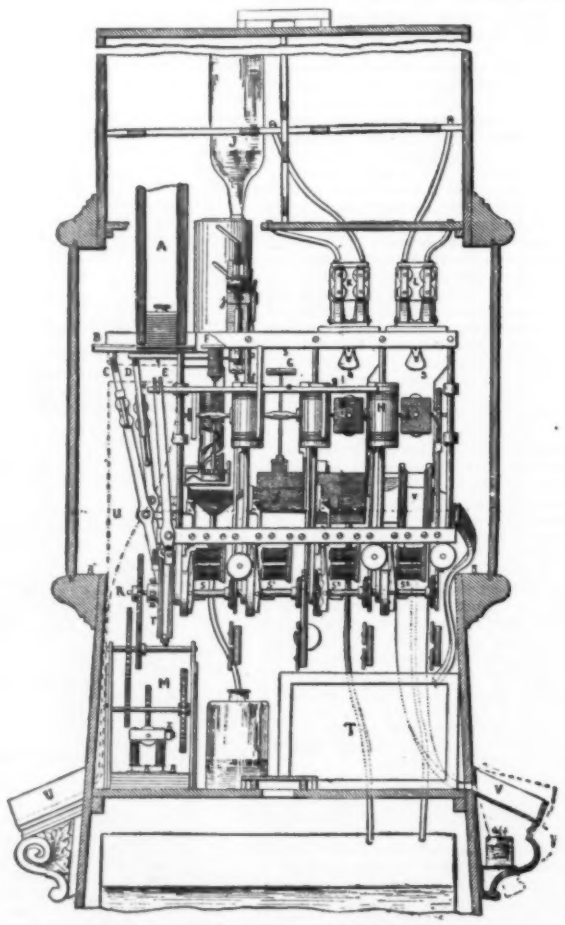


FIG. 4.—ENJALBERT APPARATUS.

five distinct compartments, designated in our figure by the numbers, 1, 2, 3, 4, and 5.

The first compartment contains the plate holder, A, which is formed of four uprights, between which are placed the plates, separated by copper frames that are placed crosswise with respect to the plates, so that when one plate has been carried along by the piece, B,

and the latter has returned to its initial position, the frame, being no longer supported, falls into the channel, *u*, and makes its exit at U. This frame serves to inclose the finished picture.

At the lower part of the case there is a small electric motor, M, which receives the general current, and which, by means of a set of gearings, revolves the shaft, R, which, traversing all the compartments, transmits motion to all the parts. Upon this shaft is fixed a cam, *r*, which actuates the three rocking levers, C, D, and E. The first two are connected electrically with the first dial (Fig. 5), and each terminates in a small fork, which, under the action of an electromagnet, is capable of oscillating in a plane at right angles with theirs.

The coin, having been introduced into the slot shown

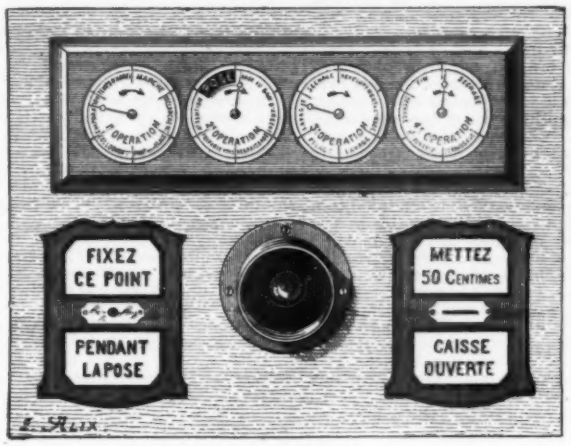


FIG. 5.—ENJALBERT APPARATUS.

in Fig. 5, falls on a plate and causes a lever to tilt, and this establishes a communication. The current passes into the electromagnet in compartment 2, and, at the same time, sets the motor, M, in motion.

The electromagnet, attracting the vertical lever opposite its poles, fixes the sleeve, S, upon the shaft, which carries it along in its motion. By an arrangement of a toothed sector and a cam, upon which we shall not dwell, the head of the support, F, is brought against the plate holder, A. At the same moment, the first contact of the dial sends the current into the electromagnet of the lever, C, and rights the head of the same, which seizes the hook of the piece, B. This latter is driven to the right, carrying with it the plate, which is deposited upon the support, F, where it remains fixed by the action of the current that traverses the electromagnet of this support. The second contact produced upon the dial has caused the coin to fall into the box, I, and the first lever resumes its initial position. The third contact causes the current to pass into the lever, D, which actuates the drop counter, *j*, which spreads over the plate a small quantity of collodion contained in the reservoir, J. An oscillating motion given the support, F, spreads the collodion over the plate and causes the excess to fall into a funnel underneath, whence it runs into a reservoir placed at the bottom of compartment 2. The cam, *r*, then attacks the lever, E, which presses the rod, *e*, provided with prongs, which causes the plate to pass from F to G. The support, G, holds the plate in the same way as does the support, F, and immerses it in a vessel, J, containing a bath of silver, where it is shaken several times.

Then the support rises, and the plate, now sensitized, is presented behind the objective. At this moment the needle of the second dial passes over the words, "Get ready," and "Attention," and the person to be photographed takes his seat and remains immovable during the whole time that the needle is passing over the word "Exposure." The commutator of the dial sends a current which raises the shutter, and, at the same time, actuates a bell which rings during the whole time of the exposure. When the latter is finished the shutter drops, the cam, *r*, always acting upon the lever, E, and the rod, *e*, causes the plate to move forward to compartment 4 upon the support, *h*. The sleeve, S^1, which had replaced the sleeve, S, for the preceding operations, is disengaged in its turn, and the shaft this time actuates the sleeve, S^2. The support, *h*, brings the plate under the cock placed under the vessel, K, and terminating in a flattened nozzle.

The maneuver is the same in this compartment and in compartment 5 as in the two preceding. After the liquids have acted upon the plate they fall into funnels placed under the supports, *h* and *i*, and thence run into a reservoir under the case, M. Lastly, the movable support, *i*, turns over and its head grasps the lower edge of the plate on the upper edge of the conduit, *v*, so as to completely detach the plate, which drops into the conduit and finally reaches the inclined plane, V, which is heated by a small alcohol lamp, and where the plate is dried. The different phases of these latter operations are indicated by the needles of the last two dials, just as the former were by the first two. The operation being finished, the words "Case open," which had been replaced by the words "Case closed," again appear, and the slot into which the coin was introduced is uncovered.

Messrs. Karl Ramspech and Barthold Schäffer, of Hamburg, have devised an apparatus in which the plates are likewise prepared in measure as they are needed. The mechanism is actuated either by clockwork or by a small electric motor, and is very simple. The principal part is a vertical shaft revolving upon pivots and provided with an arm that carries a plate holder frame on one side and a counterpoise on the other. The different baths are placed in cylindrical vessels arranged in a circle around the central axis. The operation will now be readily understood. After the coin, on being introduced into the apparatus, has thrown the mechanism into gear, the shaft begins to revolve along with the arm that carries the frame. This latter takes a plate from a receptacle at the upper part of the apparatus and carries it to the vessel containing the collodion. At this moment, the arm inclines and the plate is dipped in the bath, and, the rotary motion continuing, it reaches the nitrate of silver bath. The arm again inclines, as before, and the plate being thus sensitized, presents itself back of the objective. There is a short stoppage of the rotary motion while the shutter rises for an instant in order to permit the light to strike the plate. When the shutter drops, the rotary motion of the shaft is resumed, carrying the plate in succession to developing, washing, fixing and washing baths, in which the immersion is effected as before described. The operation finished, the plate drops into a conduit, which guides it to the exterior. It will be seen that, in principle, the operation is simpler than in the Enjalbert apparatus. It remains to be known whether the apparatus will give good results in practice.

Fig. 2 shows the exterior of an apparatus devised by Mr. Steffen, of Chicago. In this apparatus the plates are sensitized in advance, and their motion toward the objective is brought about by the action of a weight, nearly as in the Canto apparatus. The shutter is freed by an electric current, and the plate, after exposure, falls upon an endless band which carries it successively to a series of trays containing the developing, fixing, and washing baths. The apparatus is provided, besides, with a magnesium powder lamp, actuated likewise by electricity. It is not stated whether the apparatus has been constructed or not. So it would be impossible to judge of its value.

Messrs. Karl Foge, Karl Griese, and Joseph Roders, of Hamburg, have taken out a patent for quite a simple apparatus, the entire mechanism of which is actuated by clockwork. The objective is placed in the interior of the case at the extremity of a sort of funnel, so arranged that when a person drops a coin into the slot, it is just at the point for an exposure. The descent of the coin frees the shutter, which immediately drops under the action of a counterpoise: the exposure is finished. During this time the coin proceeds on its way and strikes a second lever, which frees a tappet that keeps the clockwork from running. The axis of the latter carries a disk provided with pins, which, abutting one after another against a lever, cause a descending and ascending motion of the plate holder frame. The latter dips in succession into the series of baths contained in cylindrical vessels carried by a disk which revolves slowly around a vertical axis, so that each of them presents itself in turn under the plate. The external dial shows, as in the Enjalbert apparatus, the succession of the operations, and the slot into which the money is introduced remains likewise closed as long as the plate remains within. A second clockwork movement, actuated by the first at the desired moment, causes the exit of the finished portrait and the placing behind the shutter of another plate, derived from a receptacle arranged at the upper part of the apparatus.

The Fischer apparatus does not differ much from the preceding. The movement is wholly mechanical. The plates, previously sensitized, are arranged upon the circumference of a wheel which allows them to fall into a nearly vertical conduit, and they are stopped opposite the objective by a tappet for a length of time necessary for the exposure. They are then grasped by a sort of clamp carried by a horizontal shaft which revolves around a vertical axis, and is capable, at the same time, of sliding along such axis. Owing to this double motion, the clamp carries the plates in succession to each bath, plunges them therein, and agitates them several times.

We have already spoken of the Joel apparatus, which is but a modification of Mr. Canto's, which, as we have already said, has not proved a success.

Another apparatus, for which a patent has been taken this year, is that of Messrs. Fisher and MacFarlane. The motion here is effected by a clockwork mechanism divided into four parts and operating in succession. The first, which brings the plate from the holder into the camera obscura, sets the shutter free, ignites the magnesium lamp, and deposits the exposed plate upon a support; the second causes the plate to pass to the developing and washing baths; the third into a fixing and a second washing bath; and the fourth to a drier, and then to a shelf, whence it is taken by the sitter. The mechanism appears to be very well elaborated, but its complication is such that it must lead to its often getting out of order.

Among all these apparatus, two only are provided with a flash lamp. It must not be thought, however, that these lamps, or any other artificial system of lighting, for that matter, can be dispensed with. In fact, as all the operations are performed in a time fixed in advance, whatever be the degree of intensity of the light, it follows that it is necessary, too, in order to obtain portraits that shall be always the same, to have constantly the same illumination, and this can be effected only by having an artificial light.—*Les Inventions Nouvelles.*

PLATINIZED GLASS.

SOME very curious specimens of glass have existed for a long time in the galleries of the Conservatoire des Arts et Metiers at Paris. These consist of pieces of platinized glass that form mirrors when looked at by reflected light, and that are transparent when observed by transmitted light. The metalization of glass with platinum was effected more than thirty years ago by two skillful chemists, Messrs. E. and H. Dodé. This remarkable invention, which, as we shall see, lends itself to several interesting applications, was abandoned for a time, but the inventors have just taken it up again and have obtained from it, from various points of view, results that are well worthy of notice.

The Messrs. Dodé are manufacturing articles of pressed glass covered with a layer of platinum that gives them the aspect of polished metal. The platinum used in this way is capable of being gilded by electro-metallurgy. A very curious and artistic application is the glass to replace muslin glass. We have seen at the Messrs. Dodé's establishment specimens of glassware with designs in platinum that can be varied to infinity. These pieces of glassware are first completely metalized, and then, according to the decorations or inscriptions that it is desired to obtain, the design is formed with mineral pitch, as in the process of engraving on glass. Then the platinum is eaten away by acid. The glass reappears, and the design stopped out with pitch remains in platinum. The effects obtained are very happy. Glass thus prepared can be very effectively used in the decoration of rooms.

What especially attracts one's curiosity among the applications of platinized glass are the platinized mirrors, which may be called opaque or transparent mirrors according as they are illuminated, as we have above said, in front or behind. Transparency is utilized by the Dodés in the manufacture of a very amus-

FIG. 1.

FIG. 2.

APPLICATION OF PLATINIZED GLASS TO THE MANUFACTURE OF MIRRORS THAT BECOME TRANSPARENT THROUGH TRANSMITTED LIGHT.

ing sort of surprise. The mirrors are set in frames. In a panel behind the latter there is an aperture closed by a shutter. As the glass is transparent there may be seen through it, when the shutter is opened, everything that is on the other side. It has occurred to the inventors to utilize this transparency by placing an image or a photograph between the panel and the glass. On exposing the mirror to the light in order to look at one's self, if the shutter be opened, the face will disappear and be replaced by the photographic portrait or the image that has been placed behind the glass. These images are not apparent, and when the panel is closed, the mirror has its ordinary aspect.

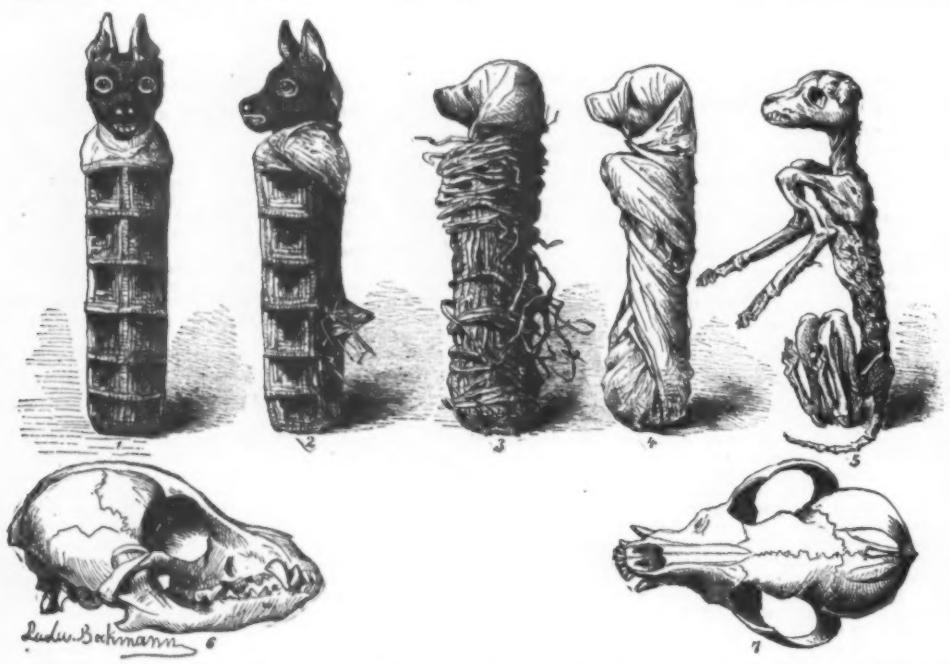
The Messrs. Dodé have installed mirrors of the largest size in their manufactory. We represent one of them herewith. When light is thrown in front of the mirror (Fig. 1), the visitor sees himself by reflection. When the back of the mirror is illuminated, he sees by transmitted light the object placed on the other side, which in the present case is the head of a devil, whose body is hidden by two mirrors inclined at an angle of 45°.

The change of illumination is easily effected by means of the electric light.

These platinized mirrors may be used in various ways. Placed in the panels of doors they will light up dark corridors or halls, and, on the other side, they will form reflecting glasses or mirrors. Behind such a mirror one can see without being seen. Platinized glass may be used for making magic eye glasses. Those who wear them can see through them, while viewed externally the glasses look like opaque mirrors.

For the lover of amusing physics there are here very numerous subjects of recreation. It is easy to install a magic mirror in front of a closet. It will suffice to form an aperture in the door and to place therein a platinized glass, which will form a mirror, and which will allow an object to be seen in the closet when a light is turned up in the latter. It seems proper to terminate this note with a description of the process of manufacturing these mirrors.

Platinized mirrors are obtained by a concentrated solution of platinum, brought to the state of crystallizable chloride, upon which one pours essential oil of lavender. A liquor is formed in which the platinum is held in suspension, and which is placed upon the glass in very thin layers by means of a pencil. Especial care must be taken to avoid dust, which is very detrimental to an operation of this kind. The mirrors having been thus coated are put into a drying room and then into a muffle of refractory earth or of cast iron. The muffle is hermetically sealed and raised to a red heat. After cooling, the glass is taken out. These mirrors, after being rubbed with a cloth and Spanish white, are very bright and reflectant. Their tone is a little less white than that of mirrors made with silver or mercury, but they give sharper and more faithful images.—*La Nature.*



1. Front view of the complete mummy. 2. The same in profile. 3. The mummy with the outer covering removed. 4. The inner wrapper of a fabric coated with asphalt. 5. The dried corpse. 6. The skull in profile; $\frac{4}{10}$ actual size. 7. Plan view of the skull; $\frac{4}{10}$ actual size.

EGYPTIAN MUMMY OF A HOUSE DOG.

(From drawing taken from a specimen recently found.)

EGYPTIAN MUMMY OF A HOUSE DOG.

IN December, 1890, the writer of these lines received, through acquaintances in Cairo, the mummy of an animal supposed to have been found near Thebes, which was said to be a "mummy of a cat," but proved, on careful examination, to be one of a small house dog about as large as a medium sized greyhound. As mummies of dogs are, to say the least, much more rare than those of cats, and as the technical treatment of the specimen before me differs in many respects from that of the cat mummies, a description of it should be of interest.

The external appearance of the mummy, front view, is shown in Fig. 1. The colors are limited to a yellowish white and a deep asphalt brown. Possibly the lips and eyes were formerly colored, but this cannot be known with certainty. The outer wrapper consists of a fine, closely woven fabric, something between silk and linen. The entire fore part of the body is besides covered with extremely ornamental basket work made of small strips of the same fine stuff. The head, with the long erect ears, is skillfully represented by many layers of cloth glued over the real head, and the connection between the latter and the cylindrical body is covered by a piece of cloth put on shawl fashion. It is worthy of note that, in the whole wrapping, there is no trace of sewing or winding about with cords or threads.

The edges of the single pieces of cloth are carefully turned down, and have, apparently, been pressed with some heavy object, such as a sad iron. The basket work on the front and on the parts around the eyes and lips are also made of strips of cloth with turned down edges. Besides the asphalt a colorless gum is used for gluing the white cloth.

Fig. 2 is a side view of the mummy, and in Fig. 3 we see it freed from its outer wrapper. The body is here closely and uniformly wound with a long cord made of rushes, the long stems being tied together by peculiar but simple knots. When the cord was unwound it was found that the entire front of the body was covered with a layer of rushes cut in various lengths and laid straight so as to fill in the uneven places.

Fig. 4 shows the mummy in its last, or rather first, wrapper. This consists of crossed bandages of coarse material, and under these is a still coarser material resembling sackcloth, which is so saturated with asphalt that it is inseparably combined with the epidermis and the hair, forming a thick black coating. The ears, which are pressed forward on the head, are partly formed of this same layer.

Fig. 5 shows the corpse freed from all its wrappings. The muscles have in the course of time changed to a fine, powder-like dust which lies in the cavities of the body. The skeleton is only held together by the dried and shrunken skin; all ligaments and sinews have disappeared. On the other hand, the bones are well preserved, and the skull (Figs. 6 and 7) is scarcely distinguishable from one which has been recently prepared, but many of the teeth show an inclination to split lengthwise. Judging from its teeth, the dog could not have been more than a year and a half old. One fore leg is somewhat crippled because of a break in the bone which was badly healed.

The size of the skeleton, the form of the skull, etc., indicate that the animal must have been something between a greyhound and a black-and-tan terrier of the present day.—*Illustrirte Zeitung.*

INTRODUCTION ON THE GENERAL CHARACTERS OF MOSSES.*

By Prof. LEO LESQUEREUX.

1. *Mode of Propagation of Mosses.*—Mosses are reproduced by the germination of spores or by propagules. The seminal granule, or spore, is a small, round body, formed of two membranes; the outer, *perispore*, more solid, often granulose on the surface, generally of a peculiar color; the inner, soft, hyaline, and containing the elements necessary for germination. When perfect spores are ripe and exposed to humidity, the inner membrane becomes swollen, the perispore is ruptured, and allows the protrusion of the primordial cell—the first growth of the moss named *proembryo*. This proembryonal utricle is first divided into two cells, which by subsequent subdivisions constitute more or less elongated filaments, which, by anastomosing at various angles, compose a confervoidal tissue, *prothallium*, upon which buds of new plants are developed. Another mode of reproduction of the mosses still more frequent is from the development of buds, tubercles or filaments derived from different parts of mature plants. Effete leaves, branchlets, lenticular granules, *pseudopodes*, attached to the leaves or the stems—all have the property of sprouting into radicals and producing new plants.

2. *The Root.*—This organ, essential for fixing the plants to their place of growth, is found in all mosses. As rootlets, or radicals, they are not only attached to the base of the stems, but often distributed in fascicles along the stems and the branches, which they sometimes cover as with a matting or *tomentum*. They may even appear at the top of the branchlets or upon the surface of the leaves. They are composed of a single series of oblique cells with contiguous walls (*parietas*). They are either simple or at length forked, or in fascicles. So-called "creeping roots" are merely subterranean branches, *stolons*, analogous to rhizomes—a continuation of, or shoot from, the base of the plant.

3. *The Stem.*—Though sometimes very short, the stem is present in all the mosses. In the annual *Acrocarpi* it is generally simple; but it becomes compound by repeated simple, double or multiple innovations when perennial. It is truly ramified only in the *Pleurocarpi*, whose lateral fructification does not impede the growth. For in the *Acrocarpi*, the fructifications being terminal and late, the annual development is continued only by lateral gemmules from under the flowers for the vegetation of a second year. As these annual innovations are not always simple, but in twos, threes, or more, the old plants are sometimes simple, sometimes double, or many times dichotomous, or fastigiately branched. In the *Pleurocarpi* the ramification is very varied, diffuse, pinnate, bipinnate, ramulose, fasciculate, etc.

4. *The Leaves.*—The leaves are present in all mosses, in their natural state of development. They are generally horizontally attached to the stems, sometimes obliquely, rarely vertically. Their relative position varies in different species—sometimes even in different parts of the same plant. The characters of the leaves, their mode of attachment, their forms, the divisions of the borders, which are never lobate, but entire, or dentate, or ciliate, etc.—the appearance of the surface—opaque, glossy, papillose, etc., are expressed by common botanical terms. They are generally formed of a simple stratum of cellules of various forms, or, in rare cases, of superposed, double or triple layers of cellules.

5. *The Organs of Generation.*—The flowers of the mosses, like those of the phænogamous plants, are unisexual or bisexual; they are polygamous or synœcious when male and female organs are mixed in the same involucre; monœcious or autœcious when in separate buds on distant or separate branches; parœcious when the antheridia are free in the axils of the perichœdial leaves; androgynous or hypogynous when the male and female flowers are close to each other or separated by a single leaf. In the *Acrocarpi*, the flowers, either female or bisexual, are produced at the top of the stem or of the innovations. The male flowers are sometimes similarly placed, but more generally on the sides of the branches, especially at the base of the female flowers, which throw them aside in their growth. In the *Pleurocarpi*, the flowers—always lateral—are upon stems or branches. Polygamous as well as female flowers are inclosed into a kind of involucre of imbricated leaves, of which the inner ones, originally the smallest, gradually increase in size during the evolution of the fruit, forming a peculiar envelope, *perichætium*, which surrounds the inflated oval support of the pedicle, the *vaginule*. The involucre of the male flowers, *perigonium*, is not subject to a modification of the same kind, though the inner leaves generally differ from the outer in some characters. The female organs of the mosses, *archegonia* or *pistillidia*, show the greatest analogy to the pistils of the phænogamous plants. They are flask shaped bodies, each with a cellular covering, narrowed upward into a cylindrical tube, *stylidium* or *collum*, which, variable in length in different species, remains closed until the anthesis, when it opens by an enlarging, funnel-like mouth, to receive and give passage to the fecundating matter. The archegones are more or less numerous in the different species—two to thirty or even more—but generally only one is fructified, rarely two or three, the fruits in this case being clustered in the same perichœtium. The male organs of the mosses, *antheridia*, inclosed with *paraphyses* in the *perigonium*, are generally composed of two parts, a utricle of an oval elongated form, rarely globose, containing the spermatozoid matter, and a pedicle, either short or somewhat elongated. When replete, the antheridia are swollen, greenish white or hyaline at the apex; when empty they become flaccid, rugose, reddish or dirty yellow, and deformed by compression. At the time of fecundation the subclavate bacillate spermatozoids convolute in spiral, being free from the spermatozoid mass wherein they are mixed, have a spiral motion of their own—like small living animals—and penetrate the archegones through the cylindrical tube. The number of the antheridia is, like that of the archegones, variable according to genera and species. Filamentose organs, *paraphyses*, are mixed with the antheridia and archegones; they vary in their form and their number. They are generally as long or even longer than the antheridia; filiform and slender in gemmaceous flowers, subclavate, spathulate, etc., in discoid or anthoid ones.

6. *The Fruit.*—In ripening, the base of the fertilized archegone gradually enlarges into capsule, *theca*, composed of two walls; the inner, *sporogone*, or *sporange*, soft, thin, which at maturity contains the spores, and which either adheres to the outer walls, or, free, except at its base, is like a small cylindrical bag attached to the outer walls by filaments. In the process of its growth, the cellular part covering the sporange becoming dry and membranaceous is transversely ruptured at its base, and forms the *calyptra*—a cover which, pushed upward, is either split on one side and thrown up obliquely (*cuculliform*), or is gradually expanded, and sits upright upon the capsule like a conical hat (*mitriform*), either entire or lacerate at its base. In rare cases it remains attached to the base of the capsule, which then passes through by a longitudinal slit of its side. It is also sometimes *dimidiate*, or split on one side in its whole length. The capsule itself, formed of a somewhat hard, solid membrane, composed of two or more series of cells, is variable in size, shape and color in the different species of mosses. It is generally more or less perforated by stomates toward its base. In most species the capsule is gradually narrowed downward to a neck, *collum*, or an *apophysis*. The collum is merely the obconical upper part of the pedicle, while the apophysis is a more or less long prolongation of the inflated base of the capsule, from which it generally differs by consistence and color. In some species it is as long as the sporange, or even longer, being an intermediate part between it and the pedicle. The *pedicle*, or basilar support of the capsule, is sometimes short or scarcely discernible, though present in all mosses. It is generally filiform, cylindrical, of equal thickness in its whole length, except under the base of the capsule. It is more or less rigid, elastic, generally smooth on its surface, sometimes rough, scabrous or verrucose. The

* From *Popular Science News*, March.

lid, or *operculum*, also in all mosses except the *Cleistocarpi*, the *Holocarpi*, and the *Schistocarpi*, is the apex of the capsule, which becomes circumscissile, and is at length detached as a kind of cover. It is variable in shape, length, color, and affords very valuable characters for the diagnosis. The *annulus* is a narrow fringe composed of one, two, or three series of hyaline cellules at the orifice of the capsule. The cellules, contracted by dryness when the capsule is ripe, and abruptly dilated by humidity, force the disruption of the lid. These cellules are detached from the orifice in fragments, or else they remain adherent to the lid, or fall together from the mouth of the capsule as a spirally twisted narrow fringe. The *spores* or *sporidia* inclosed in the capsules, deformed by compression when young, become globose in ripening; they are sometimes angular, but generally smooth or rugulose. They are greatly variable in size—from 1-5 to 1-100 mm. in diameter. They also vary in number; species of *Archidium* have no more than fifteen or twenty spores in each capsule; in the *Hypnaceæ* the spores are very small, and, indeed, innumerable.

The Peristome.—When the lid is removed the orifice of the capsule, in most of the genera of mosses, is seen to be adorned by a simple or double, very rarely triple or quadruple, row of small teeth and cilia, called the *peristome*. When simple the peristome is composed of eight, sixteen, thirty-two or sixty-four teeth, attached to the orifice of the capsule or a little lower inside of it; sometimes tubulose, or prolonged above the orifice into a cylindrical tube. The teeth are simple or compound—that is, in this last case they are formed of two or four similar parts adhering or united by the borders, and thus geminate or bigeminate. These parts often separate with age, doubling or quadrupling the number of the teeth. A colored line marks the union of the teeth or the line of division. The teeth are very variable in size, form, and color, affording important characters for the diagnosis. When the peristome is double, the inner is generally composed of a pellucid, yellowish membrane, *processus*, of various lengths; it is rarely entire, sometimes irregularly lacerate, generally cut into segments and cilia. The segments are usually plicate-carinate lengthwise, more distantly and less distinctly articulate than the teeth. The cilia are generally narrow, filiform, distantly articulate, sometimes barred (appendiculate) at the articulations. They are also derived from the inner membrane, and are alternate with the segments.

The *columella* is a cellular cylinder, or axis, which occupies the center of the capsule, from its base to the top of the lid. It is generally fugacious, and soon breaks up or decays. In a few mosses, however, it persists and remains attached to the lid, supporting it above the mouth of the capsule when this becomes dry and effete.

Mosses live everywhere and on various kinds of material. On cricks or on coarse sandstone, to which they are attached by short radicles penetrating the porous matter, are species of *Desmatodon* and *Barbula;* on coarse gravel along roads, *Trichostomeum;* on the sand and naked earth of the plains, the *Cleistocarpi*, the *Pottoideæ*, and the *Weisieæ;* on clay banks, *Fissidens* and *Dicranella;* on the wood of living trees, the *Orthotricheæ* especially; on that of decayed trunks or branches, the *Dicraneæ*, the *Hypneæ;* on the dung of animals, the *Splachneæ*, etc. Their especial province in nature is to absorb and concentrate atmospheric humidity, and to retain it in their texture, either to hasten the decay of the dead woody matter to which they are attached or to retard it when life still remains in the plants. They cover and protect the roots of trees and their base against atmospheric influences, cold or heat; they overspread waste fields, swamps and bogs and by their gradual decay produce peat or humus. They are thus modestly pursuing everywhere a constant work of usefulness, always bearing a pleasant aspect, giving the appearance of life, and hiding the hand of death wherever its decomposition is at work.

Mosses are found in every station, under every kind of climate, and bear an uninterrupted life. They have their seasons for fructification, but even when dry and discolored under the influence of heat, they take life again and continue to vegetate as soon and as often as they receive a sufficient amount of humidity. Hence the botanist is never disappointed in his search for mosses. At every season some species bear their fructification, and are therefore determinable. They need no care for their preservation; heaped in bundles or dried they may be left aside for years, and when needed for comparison and determination, immersion in water revives them, and at once they open their leaves and become as fresh and green as if they had just been gathered.

NOTES ON THE LATER LIFE HISTORY OF THE FLOWERING DOGWOOD (CORNUS FLORIDA, L.)

By M. ALSTON READ.

THE genus *Cornus*, to which the dogwood belongs, is divided into two minor groups, one characterized by having "a head, or close cluster of greenish flowers, surrounded by a large and showy, four-leaved, corolla-like, white or rarely pinkish involucre; fruit bright red." The other has "white flowers in open, flat, spreading cymes; involucre none." The subject of this paper is to try and show the derivation of the first group, which consists of the flowering dogwood and the cornel (*C. Canadensis*). The four large, white, petal-like expansions are not petals at all, but merely bracts—altered green leaves that grow near a flower. They form one of nature's many devices for securing conspicuousness, in order to attract the attention of flower-loving insects, that they may effect cross-fertilization for the plant, cross-fertilization being—as Mr. Darwin has so forcibly shown us—the great object of plant economy. This is effected by insects, which transport the pollen of one plant to the sensitive stigma of another. This beneficent act is not intentional on the part of the insect, but is simply a result of his flower-visiting propensities; the pollen becomes entangled in his hairy coat, and thus gets carried to the flower next visited.

The dogwood is a very showy and conspicuous plant in flower, and scarcely less so in fruit, as clusters of red berries gleam through the green foliage. It thus seems well endowed with attractive features. The flowering dogwood and cornel are probably recent offshoots from the rest of the genus, to which they bear no resemblance to a casual observer; for on the one hand we have what seems to be a single large white flower with a central head, and on the other we have a loose bunch of small white florets.

I said above that *C. Florida* and *C. Canadensis* were derived from the second group of the genus, and not the second group from them, for the following reasons:

1st. These two form a much more specialized group, which means that they are later (the specializations are simply modifications of the family plan) and higher in the scale. They have crowded all their florets in

CORNUS FLORIDA.

Flower bud. Flower head. Terminal bud protected by being inclosed in a sheath of the petioles.

a dense head, so that a large number can be fertilized at one visit—as in the common daisy—and thus a number of seeds set from a single visitation.

2d. In the head the flowers are of different ages, there being some in which the stamens are ripe and others in which the pistils are ripe. When an insect lights on this head, he fertilizes those in the second stage and gathers new pollen from those in the first stage, as he turns round to suck the separate flowers in turn.

3d. Because the majority of the plants of the same genus, as well as those of the allied families, are simpler and display the open cymose type of inflorescence. When you see a general, simpler type prevailing in several allied families, you may be sure that they, or their common ancestor, gained those characteristics before they broke up into separate groups or families. And any small departure from them in the limits of a genus points to a more recent modification.

The steps by which the dogwood and cornel reached their present state were, it seems to me, somewhat like these.

The species which, through some process of natural selection, first started toward the dogwood type packed the florets of its cymose head closer together, and gradually reduced their number. These two steps may be still observed, for in *C. sericea* the cymes are flat and close, and in *C. stolonifera* the cymes are small, flat and few-flowered. In course of time four bracts began to assume the size, shape, and office of petals, in order to increase the showiness of the plant.

There are numerous bracts scattered all through the cymes of the second group; especially near the edge they are larger and more numerous, as they are here less crowded out. (There are bracts surrounding the single florets, even of *C. Florida.*) These brachts are whitish green, which was probably the original color of the white petal-like bracts.

Concomitant with the development of these large

CORNUS FLORIDA.

Flower head, much enlarged, and with some of the florets removed, for greater clearness.

bracts, the florets forming the head come closer and closer together. The bracts now serve both as a protection and an attraction; but at first they were, most probably, protective only, or largely so, and only later attained their white color.*

These bracts are merely brownish gray scales in the bud, folded over the head of the true flowers; and when they open they grow rapidly into a broad white expanse, still bearing the little scale-like part at the tip. The flowers themselves have become quite specialized, for instead of having flat, spreading sepals and petals, like their nearest allies and the rest of the genus, they have gone a step farther and have produced their coherent sepals into a tube, which, as in the pinks, holds their petals in a tubular form also.

This excludes a horde of miscellaneous small flies, and courts only those with longer tongues, which are thereby enabled to reach the bottom of the tubes. The plant thus narrows its field, but gains more efficient workers as a compensation for diminished numbers. The anthers are erect and exserted, and can hardly fail to dust any insect of the above description that happens to light on the flower head. At this stage the flowering dogwood and the cornel separated, for the latter, as will be seen in the figure, has not reached the perfection of the former; for, while the flowering dogwood has a perfectly compact head, with all the florets borne on an expanded and modified apex of the stem—which is thus made to perform the offices of a receptacle—the cornel still retains decided traces of the original cyme, and the florets are borne on very short branches.

So much for the flowers; now let us glance at the berries. In these there is no difference throughout the genus, except the comparatively unimportant one of color, which depends on the selective tastes of different birds. Why was there no change in the berries? Probably because the berry of the parent form was good enough without change. To describe one will be sufficient, as they are much alike. The berry is a succulent, two-celled, two-seeded drupe, formed by the union of the calyx (coats) with the ovary. It swells and becomes red on ripening. A fruit in which this union of parts takes place is in advance of one in which the calyx is free.

Plants that have a drupaceous or succulent fruit generally have fewer and larger seeds than those without these facilities for dispersal. For each seed in a fruit that has fine facilities for dissemination stands a better chance of growing and becoming a plant than a dozen seeds that have poor means of dispersal; and the plant that has fewer seeds can store those remaining much more effectively than it could a larger number. How did the fruit become drupaceous? Probably by the selection of the most succulent ones by birds. Hence, those that were hard and dry perished, and the juicy ones were eaten by birds and transported by them to considerable distances, and so stood a better chance of hitting upon a good locality for growth and reproduction of vigorous offspring. As long as the seed is immature, the fruit remains hard, green, and inconspicuous, to escape notice; but as soon as it begins to ripen, it advertises that fact by assuming a bright red color. And now any hungry bird, coming along, will be sure to notice it, eat it, and the seeds, which are extremely hard and indigestible, will pass through the bird's body and be deposited in the best possible condition for germinating.

DWARF CORNEL.

Single flower. Section of fruit. Flower of dwarf cornel, magnified to show the branched head. *a*, bract removed.

The red color of the berries was produced in the same way as their succulency, viz., by the selection of birds. For if any of these fruits showed a tendency toward a red color it would greatly increase its conspicuousness, and thereby more than double its chances of being seen and devoured by birds—with the favorable consequences above mentioned. On the other hand, the green fruit would be more apt to be passed by, and hence undisseminated, so that if it grew at all it would be under the deleterious shade of the parent tree. Thus you see natural selection would tend pretty effectually to weed out the hard, inconspicuous fruits, and foster the attractive ones.

This form of fruit was probably developed *before* the flowering dogwood and the dwarf cornel branched off from the main group (for it is retained by them in common with the rest of the genus), and *after* the family *Cornaceæ* branched off from the allied families, because the *Cornaceæ* have the drupaceous fruit and the allied families have not. The bark of this family is quite bitter, and probably in a measure secures the young plant from the attacks of herbivorous animals.

All these advantages combined—the bitter bark, preserving the tender young plant; the closely packed heads of tubular florets; the conspicuous bracts, which allure the constant attention of the higher insects, and so effect cross fertilization without waste, and also serve as protective caps; and finally the attractive drupaceous fruit—allowed the plant, under certain circumstances, to spring from a shrubby to an arborescent form.

These are only a few of the facts and suggestions

* At present the bracts in some cases show a tendency to pink, and seem struggling toward a higher scale in Grant Allen's scheme of progressive coloring; and if some insects confine themselves to the pinkish ones, we may in time have a pink species evolved.

concerning the life history of this plant and are brought together principally as suggestions for further research. Among other things it would be interesting to find out which situations are preferred by the pink bracted forms and which by the white, and also the insects found most frequently in those places. Also to notice what insects visit this plant, both habitually and accidentally; to see if there is as yet any difference in the relative number or in the species which visit the two colors; to see if they exhibit sleep movements. I observed no honey (my specimens were slightly wilted), but think some must be secreted by the glandular perigynous disk of the flower, as it tasted sweet.

These are only some of the questions that suggest themselves just now; there are many more awaiting the close observer.—*Popular Science News.*

CUPRESSUS NABIANA.

THE cypress of which we give an illustration is at once one of the most distinct and one of the least known of the genus. It is a relatively low growing, very bushy species, branched from the base, and was found by Lobb, and afterward by Murray, in North California, and was first described by the late Andrew Murray in the *Edinburgh Philosophical Journal*, vol. i., p. 293, t. 11 (1855); see also *Gardeners' Chronicle*, 1855, p. 420.

The species has been mentioned, but with little additional information, by all subsequent writers on conifers, including the most recent one, Beissner, whose *Handbuch der Nadelholz Kunde* (1891), p. 100, comes to hand as we are writing this paragraph, and which will demand early notice in these columns. C. Nabiana, of which specimens have been sent us from the Edinburgh botanic garden by the courtesy of the curator, is remarkable for the dull purple red color of its tortuous branches, and the very densely crowded, closely appressed, deep green leaves. The globular cones have rounded or obtuse scales, each provided with a thick, projecting, recurved point.

It is the C. Coulteri of Glasnevin Gardens, where it was raised from seed that had been in Coulter's herbarium for twenty-one years, and has also been called C. nivalis. It is like C. Knightiani, but has less acute leaves.

In accordance with the decisions of the Paris botani-

CUPRESSUS MACNABIANA.

cal congress on nomenclature, we omit the particle "Mac," which is not in accordance with Latin usage, and of no botanical importance. In any case, if any one should prefer to use the prefix, no one will object.

The species is represented in the Kew herbarium by specimens from Murray; Lobb, 398,439; Jeffrey; Brewer, 863; and Pringle. Our illustration originally appeared in the *Revue Horticole.*—*M. T. M., Gardeners' Chronicle.*

SOAP FOR WOOL WASHING.

A GOOD soap for freeing wool of grease can best be prepared from olive and Cochin cocoanut oils. Seventeen hundred and sixty pounds of olive oil are boiled to a grain with caustic soda lye. After the soap has separated and the lye has been drawn off, 1,960 pounds of potash solution of 20° B. are added and allowed to boil a little. Now 440 pounds of Cochin oil are added, and, when well taken up, the same quantity of potash solution of 20° B. is gradually added as the soap can take it up. Then place in tinned forms of about 220 pounds capacity.

The entire process is easy, and the soap obtained is highly esteemed in washing wool, as the wool treated with it is open and has a good "feel," provided the consumer does not add any alkali to the soap solution with a view to making it act more rapidly, as is often done.

A cheap and less valuable article, such as is frequently used for cleaning ordinary wool, is also easy to prepare. Seventeen hundred and sixty pounds of elaine and 440 pounds of tallow are boiled to a grain, the precise method of boiling being immaterial provided one obtains a good firm grain. In another kettle a soda solution is prepared of 30° B. Now take 220 pounds of this soda solution, place it in a shallow kettle with 440 pounds of the grain soap, stir well and then add, with constant stirring, 220 pounds of dry soda.

In this way a thick paste is obtained, which is allowed to cool in the pan and is removed after 48 hours with a chisel. This is broken up into small pieces of the size of an egg, and packed in barrels for shipment.

A third process, which, however, is but seldom used in soap factories, is the following: Twenty-two pounds of caustic soda lye of 60° B. and 44 pounds of soda crystals are dissolved in 120 pounds of water, and 44 pounds of elaine crutched into the solution. This mixture is adapted to wool washing and is generally prepared by the wool washer himself. The wool, however, becomes dry and brittle after its use.

Almost every establishment has its own "approved" formula, and every wool washer watches, argus-eyed, lest some one discovers his method of making "celebrated" soap. We can very cheerfully let these people retain their treasure, as a soap boiler would never allow himself to apply the name soap to such a mess.—*Der Seifenfabrikant.*

THE TELEPHONE INDUSTRY.

THE annual report of the American Bell Telephone Co. shows the earnings during 1890 reached the substantial figure of $4,375,290 as compared with a little over $4,000,000 in 1889; $2,213,913 was paid out in regular and extra dividends, representing the earning and profit-yielding capacity of the capital stock of $12,500,000; while the large amount of $600,000 was carried to reserve for general depreciation, and an additional $55,500 for depreciation on instruments.

The report shows 483,790 instruments under rental, a gain of nearly 40,000 over 1889, while the number of connections reached 450,000,000, or about 3 per day per subscriber.

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